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DEEP SKY

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An Interview with ASTRONOMY's Richard Berry

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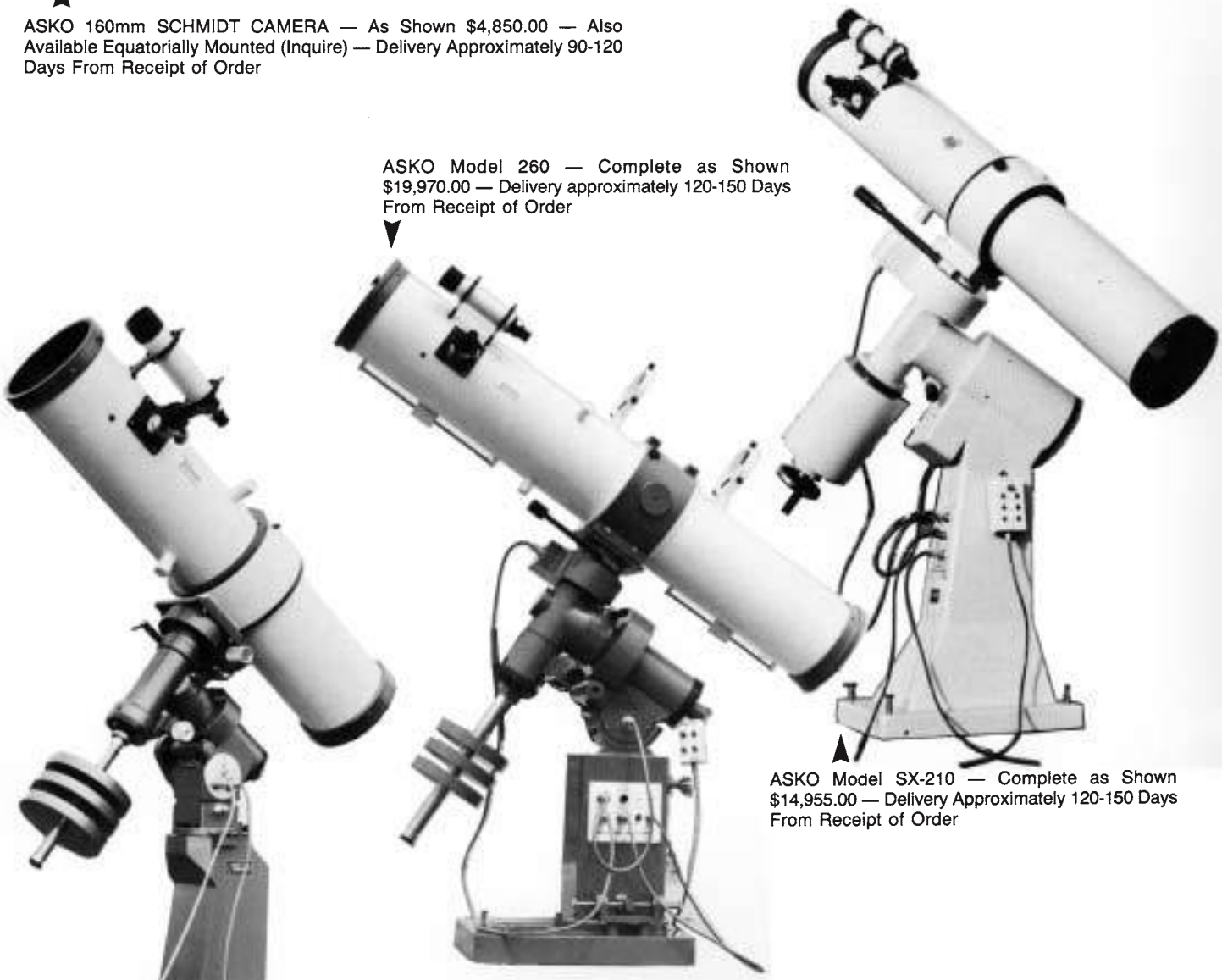

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DEEP SKY

The Magazine for Deep-Sky Observers and Astrophotographers

Spring 1983 Volume 1, Number 2

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Contents

Letters to DSM 4

Inside View 4

6 **Galaxies Around the Great Bear**
by David J. Eicher

Equipment and Techniques 14 **Using a Large Telescope**
by Jim Meketa

At the Eyepiece 17 **Exploring Open Clusters in Canis Major and Puppis**
by Brian Skiff

The Finest Double Stars of Spring
by Glenn F. Chaple, Jr.

The Challenge of Variable Star Observing
by David H. Levy

DSM Reports 26 **An Interview with Richard Berry**
The Curious Case of Copeland's Septet
Aperture Comparisons
DSM Reviews: *Galaxies*

Scanning the Literature 34

Cover: One of the brightest and most beautiful face-on spiral galaxies is M51 in Canes Venatici. Ron Potter made this photo of the Whirlpool with his 14-inch f/11 SCT and hypersensitized TP 2415 emulsion, and the exposure lasted 120 minutes. This page: Backyard telescopes of 12-inch to 20-inch aperture show a wealth of detail in M51 — knotty bright and dark patches, a bright oval core, the "bridge" to NGC 5195, and the delicate spiral structure — providing you observe under good conditions. For more on observing galaxies, see page 6.

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Letters to DSM

Dobsonians Hit France!

Dear Sir/I have received my first issue of DEEP SKY, and it is exactly the magazine I was waiting for, non-existent in Europe. I am interested in all deep-sky objects, but mainly variable stars. I particularly enjoyed W.S. Houston's interview (I have read his column in *Sky and Telescope* for years), the sound advice given to beginning "variablists," and many other articles.

The 29-inch Odyssey telescope, present at Riverside, is terrific. I enclose a photo of my new 17.5-inch altazimuth scope with Coulter optics.

This summer I shall probably have at my disposal a telescope at the famous Pic du Midi Observatory in the French Pyrenees — it will be a fast 24-inch Newtonian. I'll make sketches and photos of deep-sky objects, as well as study variable stars. If I obtain interesting results, I'll send them.

Anyhow, every time DEEP SKY will be in my mailbox, it will be a very happy day. Keep up the good work.

Christian Hanon
17, bd de la Republique
92370 Chaville FRANCE

In Memoriam

Susan Ann Arne Eicher
December 19, 1923 — January 22, 1983

Many of you have probably noticed that this second issue of DEEP SKY magazine is about a week late in arriving. No, we are not having production problems; everything is operating smoothly at AstroMedia. This was the result of a horrible personal shock I received about a month ago, when I learned that my mother, Sue Eicher, died of complications due to cancer at the age of 59.

She was born in Minneapolis, the daughter of Fred Arne and Geneva Thurman Arne, and at the age of three, moved to Dayton, Ohio where she grew up and became interested in travel, theatre, and tennis. After starting to attend Butler University in Indianapolis, she dropped out during World War II to become a production worker at Wright-Patterson Air Force Base near Dayton. After the war she was a buyer for a department store, graduated in home economics from Ohio State University, and did post-graduate work in sociology at the University of Minnesota. Eventually Sue became a medical secretary and corporate secretary in Chicago, and then a legal secretary in Sarasota, Florida.

In the summer of 1957 she married Dr. John H. Eicher, a professor of organic chemistry at Miami University in Oxford, Ohio, where they made their home. My Mom was always very loving and encouraging, and made the daily "ins and outs" of life easy because of her kindness and willingness to help everyone out. Whether it was cooking a big spaghetti dinner, just sitting around and talking, or helping out with getting an amateur magazine published, Mom's joy of life and other people constantly shone through. She fought cancer for ten years, until January 22, 1983. Daughter Nancy, 24, is now a radio/TV news reporter, and your editor, 21, is busy with ASTRONOMY and DEEP SKY.

Besides being a caring and wonderful mother, Mom became a trustee of *Deep Sky Monthly* magazine (this magazine's forerunner) and gave me lots of encouragement to keep going when things became difficult. She isn't here during this difficult time. But when I look out at the stars she encouraged me to study, I'll always think of her and how much I loved her.

With warm regards,

Dave Eicher.

Dave Eicher
Editor

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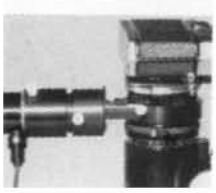

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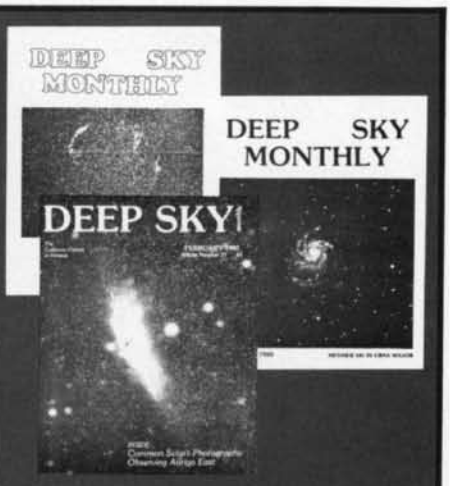
Before there was DEEP SKY magazine, there was *Deep Sky Monthly*!

Before AstroMedia Corp. — publishers of ASTRONOMY — began publishing DEEP SKY, it existed as a 20-page monthly magazine for deep-sky observers, published by amateur astronomer Dave Eicher in Oxford, Ohio. *DSM* started out as a mimeographed newsleter in June 1977, and by March 1980 became a glossy magazine, complete with observing tips, maps, charts, astrophotos, and articles for observers and photographers in tune with the current state of deep-sky astronomy. The magazine ceased publication with the May 1982 issue, after five years — 60 issues — of production. Now you can buy back issues of *Deep Sky Monthly*, while they last, in a "publisher's closeout" of the *DSM* inventory. The main article in each issue is listed below: other features, illustrations, and articles also appear in each issue. To order, send $2 for each back issue you mark on the form (or on a copy of the form), and be sure to list second choices if some issues sell out before you get your copy.



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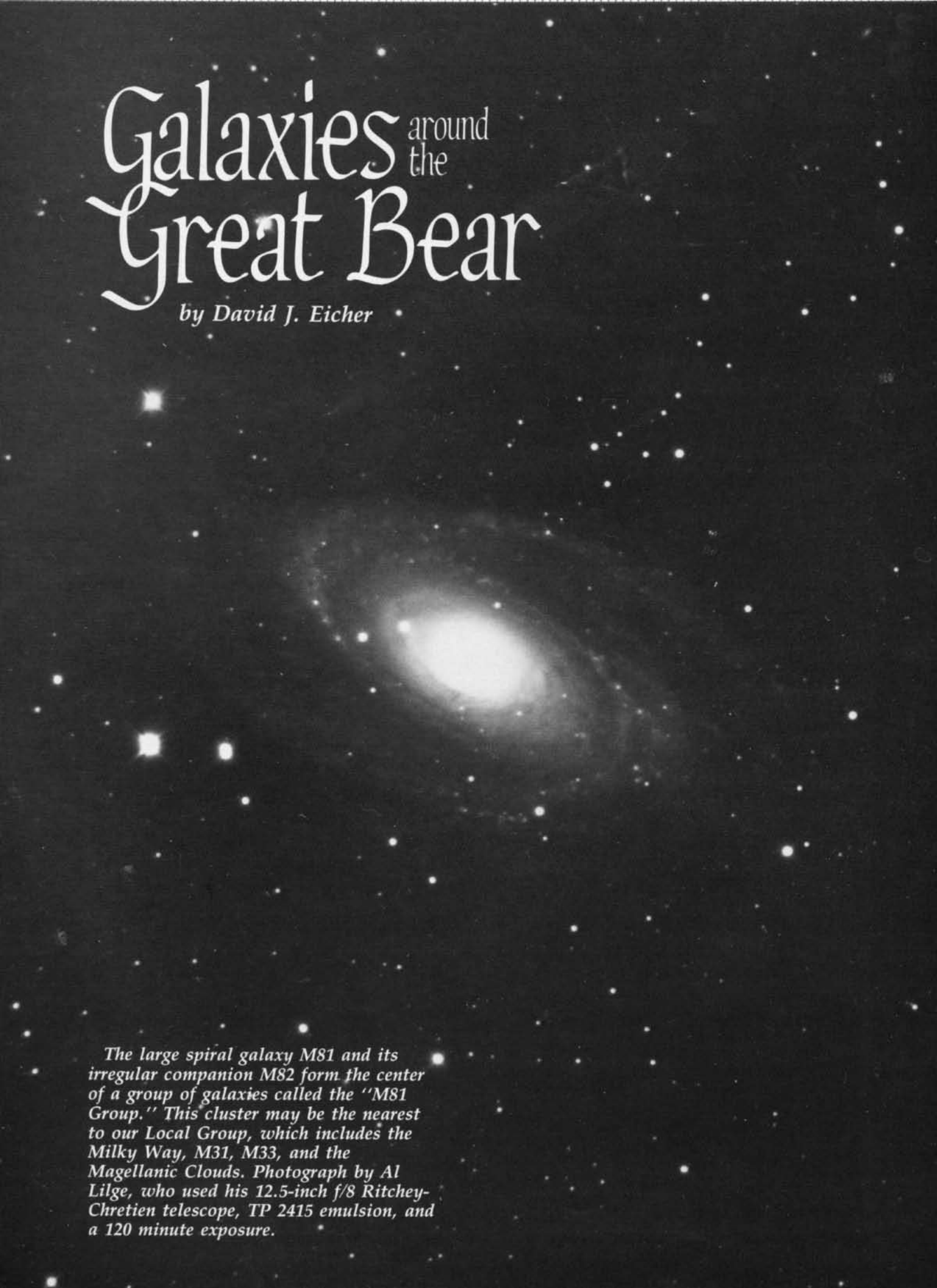
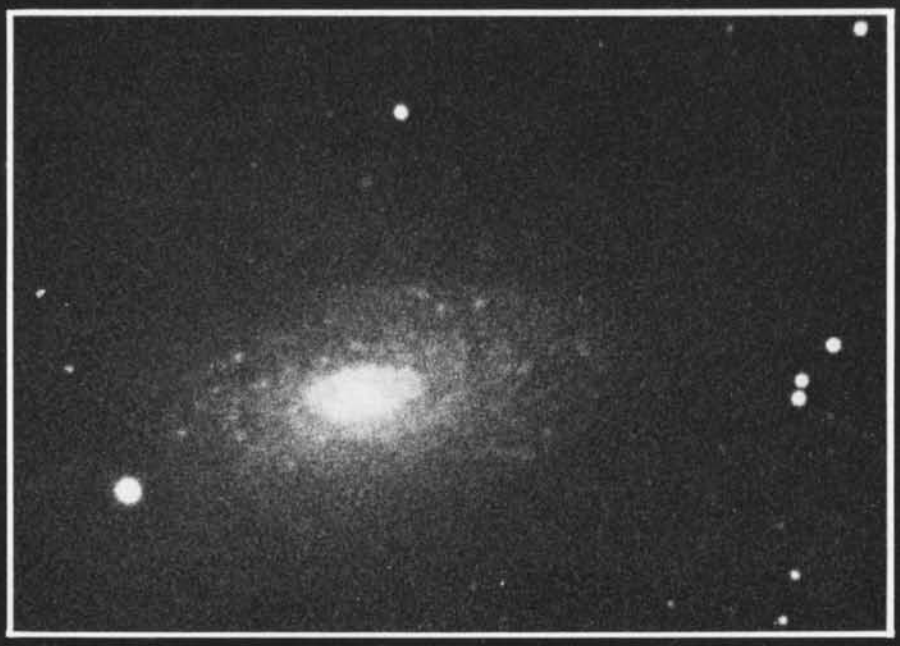
Galaxies around the Great Bear

by David J. Eicher



The large spiral galaxy M81 and its irregular companion M82 form the center of a group of galaxies called the "M81 Group." This cluster may be the nearest to our Local Group, which includes the Milky Way, M31, M33, and the Magellanic Clouds. Photograph by Al Lilge, who used his 12.5-inch f/8 Ritchey-Chretien telescope, TP 2415 emulsion, and a 120 minute exposure.



M63 is a large Sb-type spiral in Canes Venatici: in large amateur scopes, it reveals a blazing nucleus and faint spiral arms. This is an 8-inch f/10 Schmidt-Cassegrain photo, shot on 103a-F film for 60 minutes.

Martin C. Germano

Martin C. Germano

NGC 4656 is a bizarre twisted galaxy that appears to be interacting with a smaller one. This is a 90 minute exposure on 103a-F emulsion, made with an 8-inch Schmidt-Cassegrain scope.

Springtime is galaxy time: warm weather is returning, and observers in the northern hemisphere are being treated to the best display of galaxies and clusters of galaxies of the year. And what area of sky immediately pops into mind when you think of observing galaxies? Virgo, right? But there's another very rich region that offers many fine examples of galactic structure — some of which are much larger and brighter than the Virgo Cluster members — Ursa Major, the Great Bear.

The Great Bear offers a wide variety of shapes and sizes, from dim ellipticals to bright spirals like M101 and M81. Including the surrounding area of Canes Venatici, there are some 97 galaxies visible down to magnitude 12.5 in the region, so you will surely have plenty to look at this spring. Remember to observe on clear, dark nights, use the most appropriate magnifications, and *look* at the objects after you've found them — don't just casually glance once and go on to the next. You'll probably want to try your hand at sketching the galaxies, and if you do, you'll create a valuable permanent record of your observations. Whether your telescope is a 4-inch refractor or a 20-inch reflector, many fine examples of galaxies await you in the tract of sky known as the Great Bear.

Two of the most fascinating targets lie far to the north, at about 70° declination — **M81** and **M82**. These galaxies are both bright and large, and form the center of a group of galaxies which is perhaps the closest to our Local Group of galaxies. The M81 group is about 7 million light-years distant, and contains about a dozen members: M81 (also known as NGC 3031), M82 (NGC 3034), NGC 2976, NGC 3077, NGC 2403 in Camelopardalis, and a handful of faint irregular systems.

M81 itself was, along with M82, discovered by J. E. Bode in December 1774, and was added to Messier's list of nebulae in February 1781. At 36,000 light years across, it is a mid-sized Sb-type spiral, resembling M31 in stellar content. It probably contains about 250 billion suns, a third of which are located in the galaxy's central hub. Interestingly, its density is unusually high: M81 probably contains 0.1 solar masses per cubic parsec, which is twice the density of M31 in Andromeda.

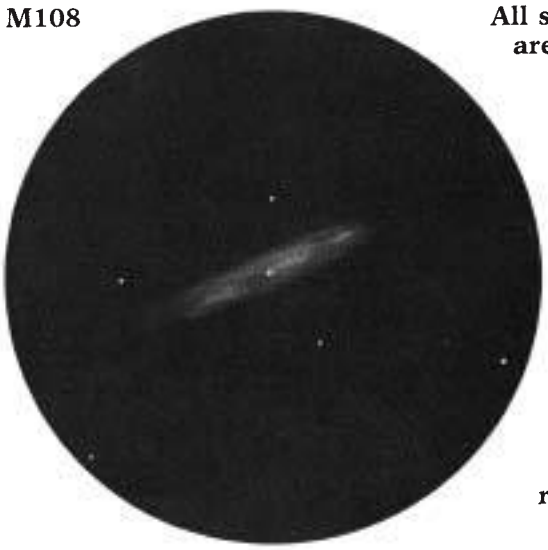
Through a low-power eyepiece, you'll be able to see both M81 and M82 in one field of view — M82 is situated just 38′ north of the spiral. M81 measures 24′x13′, and shines at magnitude 8: it reveals details at high powers in large scopes. Using an 8-inch scope in my backyard, I glimpsed an elongated very bright central core and some trace of outer nebulosity. In the same 8-incher at the 1982 Texas Star Party, however, M81 displayed delicate spiral structure, a hint of dark nebulosity running along the plane of the galaxy, and a blazing nucleus. Certainly telescopes of 12-inches or larger aperture will reveal a fair amount of detail amidst the galaxy's dusty arms.

M82 is a very unusual galaxy — it seems to have undergone a violent outburst in its nucleus about 1.5 million years ago. The galaxy is a strong radio source, and shares this odd "filamentary explosion" status with NGC 5128 in Centaurus, M87 in Virgo, Cygnus A, and NGC 1275 in

M81/M82

5-inch reflector at 70x

M108



8-inch reflector at 170x

All sketches are by the author

One of the largest nearby spirals, M101 is curiously a "lightweight" galaxy — it contains only 10% of the Milky Way's mass. On dark nights this low surface brightness object can present delicate spiral arms, a tight core, and star cloud regions in the arms. This is a 45 minute exposure on 103a-O, taken with an 8-inch f/6 Newtonian.

Brad Wallis and Robert Provin

Perseus. Astronomers used to believe that such galaxies were experiencing a collision with other galaxies, but now many lean toward a more complex hypothesis, based on studies of M82. These galaxies may have collided with giant intergalactic cloud of dust. In any case, streamers of material from M82 are visible across the face of M81: these may represent the leading edge of a shock front from the smaller galaxy.

Only 16,000 light-years across, M82 contains about 50 billion solar masses — one-fifth the mass of M81. The galaxy's redshift velocity is about 240 miles per second, much larger than M81's 48 miles per second.

A treat in the eyepiece, M82 is best observed with telescopes of at least 6-inches aperture using relatively high magnification. It glows at magnitude 9 and measures 8.9′x2.6′ across, so it appears as a silvery needle of milky light. On nights of good seeing, 8-inch and larger telescopes reveal quite a bit of dark structure intertwined with the plane of the galaxy — bright knotty patches lie alongside bits of dust.

Two smaller galaxies lie pretty close to M81 and M82, and are members of the M81 group: **NGC 2976** and **NGC 3077**. Both of these are strange dwarf systems, apparently showing some of the same characteristics as M82. NGC 2976 can be found 1.4° south-southwest of M81, and its 7,000 light-year diameter displays a mottling of star clouds and dust. It is classed as an Sc/Sd/Irr?, which alone is a tip-off that astronomers are puzzled by its structure. The galaxy's major axis is 3.4′ long, and it radiates at magnitude 11. So in most amateur telescopes it appears as a fuzzy elliptical ball, and doesn't show much detail. The same holds for NGC 3077, which is about the same size and magnitude. It is classed as an E2/peculiar, and is a dwarf galaxy about 6,000 light-years across. The galaxy can be found 45′ east-southeast of M81.

Another northerly galaxy in Ursa Major is **NGC 2685**, a lenticular system that dimly glows at magnitude 12.2. Its major axis is 2.5′ long, so you'll have to use at least 10 inches of aperture and high magnifications to see anything worthwhile with this object. The galaxy seems to have a faint ring of matter encircling its lens-shaped central mass, but this detail is impossibly faint to observe — and probably photograph — with amateur telescopes.

South of the M81/M82 area and only 3° northwest of magnitude 1.8 Dubhe (α Ursae Majoris) lies another interesting galaxy, **NGC 3359**. This collection of stars is a barred spiral, and is pretty bright at 11th magnitude. NGC 3359 is large — 6′x3′ — and has a relatively low surface brightness, but with a large scope some detail, perhaps mottling or a hint of spiral arms, should be visible. Nearby NGC 3079 is much the same as 3359, a barred spiral glowing at magnitude 11.4. It shows a slight amount of detail under high powers, but you'll have to use a large scope to see it. With a 6-inch telescope, the galaxy's 8′x1′ diameter presents itself as a thin, silvery needle much like brighter NGC 4565 in Coma Berenices.

Down south in the bowl of the Dipper is **M 108** (NGC 3556), a galaxy that lies in the same low power field as M 97, the

M109

8-inch reflector at 100x

M106

8-inch reflector at 100x

One of the brightest of the Seyfert galaxies, M94's nucleus is emitting an unusually high amount of radiation. The galaxy doesn't show a great amount of detail in most scopes, but is nevertheless interesting. This shot was made with a 16-inch f/5 Newtonian.

K. Alexander Brownlee

Owl Nebula. This Sc-type spiral is a bright and spectacular target, and should be viewed with medium to high powers (15x to 20x per inch of telescope aperture). It glows at magnitude 10.8, has a fairly high surface brightness, and shows a series of dark knotty patches running alongside its slender 8′ length. It contains only 14 billion solar masses, and lies at a distance of about 27 million light-years.

On the other side of the bowl, near Gamma (γ) Ursae Majoris, lies **M 109** (NGC 3992), a beautiful and bright barred spiral that can be picked up in the same telescopic field as the 2nd magnitude star. Using an 8-inch reflector on a dark night, you'll be able to see some of the galaxy's delicate arm structure and a blazing nuclear region, but experiment with different magnifications — M109's 11th magnitude light has a low surface brightness, so it can be a tricky object.

Between M108 and M109 and a little south of the bowl lies a pair of strange interacting galaxies, **NGC 3718** and **NGC 3729**. Both are barred spirals: 3718 is slightly larger at 3′ in diameter, and slightly brighter at magnitude 11.8. Both are rather difficult to discern in scopes of less than 6-inches aperture, but become interesting in 12-inch and larger instruments. In an 8-incher, they look like condensed fuzzy patches with pretty bright nuclei and no structure. Professional observatory photos, however, reveal faint outer arms and nebulosity spanning the 12′ distance between the two galaxies.

One of the most observed of all galaxies, **M51** (NGC 5194) can be found in Canes Venatici near the end of the dipper's handle. Shining at 8th magnitude and measuring 10′x5′, this Sc-type galaxy appears as a fuzzy patch in a 2-inch refractor and as a brighter, double fuzzy patch in a 3-inch telescope. The second object is nearby **NGC 5195**, a small 11th magnitude irregular galaxy in collision with M51. In an 8-inch scope the system is bright enough that detail can be seen on good nights: M51 looks like a large oval elongated patch that shows evidence of spiral structure, dark nebulosity, a tight core, a bridge of nebulosity to NGC 5195, and a foreground star projected onto M51's face. It is truly a fantastic sight; in large Dobsonian scopes, the galaxy becomes too detailed to accurately describe!

Because of M51's location and face-on angle with respect to our line of sight, it is of great interest to astrophysicists. The galaxy is about 35 million light years distant and measures some 100,000 light years across, containing about 160 billion solar masses. Its face-on orientation permits careful study of the elements of a fairly typical Sc galaxy: its nuclear region (which must be about 450 light years across), large twisting arms, dust patches, and placement of HII regions and stellar associations.

Messier discovered M51 in October 1773, and the galaxy is infamous for encouraging Lord Rosse's sketching of spiral structure in many types of celestial objects, including globular clusters and emission nebulae. Lord Rosse observed M51 in 1845, and probably *did* observe spiral structure. But be careful to sketch only what you see when you train your telescope on this galaxy — not what observatory photos may suggest.

On the other side of the handle is another bright Messier

NGC 4485/ 4490

8-inch reflector at 170x

NGC 4631

8-inch reflector at 100x

Lee C. Coombs

NGC 4485 and NGC 4490 compose a pair of interacting galaxies — systems whose gravitational attraction forced a collision. Can you see any evidence of interaction through your telescope? This is a 15 minute exposure on 103a-O film, made with a 10-inch f/5 Newtonian.

galaxy, **M101** (NGC 5457). Although it radiates at magnitude 9, it is spread over a 22′x20′ area, so it has a notoriously low surface brightness. Be sure to use a low power eyepiece on a dark night when you search for M101: if there is much skyglow or if you underestimate the size of the huge ghostly glow, you may miss the galaxy entirely (many observers equate M101 with M33 in this regard). Large scopes at low powers show the galaxy well, however. With an 8-inch reflector I saw M101 as a faint mass showing a bright core and a very low surface brightness haze surrounding it: I could only "suspect" spirality in the haze, and saw nothing definite. There were bright knotty patches in the haze, though — indicators of clumps of material in the galaxy's arms.

M101 is a "lightweight" galaxy in that it spans 90,000 light years across, but contains only 10% of the mass of our Milky Way. Its density is pretty low — there is only one solar mass per 522 cubic light years.

Another bright Messier galaxy is **M106** (NGC 4258), located south of the Dipper's handle. This Sb-type spiral is a fascinating object in 8-inch and larger telescopes under good skies. It measures about 20′x7′ in extent and glows at magnitude 9.6, so use medium powers (15x to 20x per inch of aperture) after you locate M106. Using a 12-inch reflector under excellent conditions, I saw some detail in the galaxy's spiral arms and dusty nuclear region. Nearby M106 — less than a degree away — lies **NGC 4217**, a 12th magnitude Sb spiral. This object appears as a faint spindle some 4′ in length, and doesn't show any sign of detail. However, observers with large Dobsonians may find it interesting.

South of the M106 region, observers with large telescopes can find an interesting pair of galaxies, **NGC 4485** and **NGC 4490**. NGC 4490 is a pretty large Sc-type galaxy, measuring 5′x2′, and shines at magnitude 10. Thus it is a good sight in small scopes, which also show NGC 4485 as a tiny fuzz near the spiral. NGC 4485 is only a magnitude 12.5 object, and spans just 1′ across. It is classed as an E/peculiar, and is difficult to perceive as anything more than a misty patch of light. Large backyard telescopes may show some mottling across the face of 4490, but probably not much more.

Astronomers disagree as to whether or not 4485 and 4490 are physically associated. Studies made by Thornton Page seem to indicate a connection of matter between the two systems, but F. Bertola's measurements show the two galaxies to have radically different radial velocities.

To the southeast of the possible interacting pair lies **M94** (NGC 4736), a bright condensed Sb spiral that glows at magnitude 9. The galaxy measures 5′x3.5′, and so is a nice target for almost any size telescope. It shows as a tightly wound compact spiral with a very high surface brightness nucleus, and presents a faint mottled halo of nebulosity extending outward from the core. Large scopes may reveal some mottling or spiral shape near the core, but its high degree of condensation makes this trick a tough one. M94 may lie only about 20 million light years away and measure 33,000 light years across, based on its total luminosity of roughly 8 billion suns.

Yet another bright Messier galaxy in the region is **M63** (NGC 5055), which makes for a spectacular view through

NGC 4656

8-inch reflector at 170x

M94

8-inch reflector at 100x

Lee C. Coombs

NGC 4214 is an irregular galaxy in Canes Venatici: its unorganized appearance shows up well in this photo, which is a 15 minute exposure on 103a-O film, shot with a 10-inch f/5 Newtonian.

Galaxies in and around the Dipper

NGC	M	Type	Con	Mag.	Size	R.A. (1950) Dec.
2639		S0/Sa	UMa	12.5	1.1'x0.6'	08h40.1m +50°24'
2681		S0/Sa	UMa	11.3	2.8'x2.5'	08h50.0m +51°31'
2685		S0/Sb?	UMa	12.2	2.5'x0.8'	08h52.2m +58°59'
2701		Sc	UMa	12.5	1.8'x1.0'	08h55.5m +53°59'
2742		Sc	UMa	12.5	2.5'x1.1'	09h03.7m +60°41'
2768		E5	UMa	11.6	1.6'x0.8'	09h07.8m +60°16'
2787		S0/Sa	UMa	12.0	2.1'x1.3'	09h14.9m +69°25'
2841		Sb	UMa	10.3	6.2'x2.0'	09h18.6m +51°12'
2950		S0/Sa	UMa	12.0	1.3'x0.9'	09h39.1m +59°05'
2976		Sc/Sd/Irr?	UMa	10.8	3.4'x1.3'	09h43.2m +68°08'
2985	M81	Sa/Sb	UMa	11.3	4.0'x3.0'	09h46.0m +72°31'
3031	M82	Sa/Sb	UMa	8.0	24.0'x13.2'	09h51.5m +69°18'
3034		Ip	UMa	9.2	8.9'x2.6'	09h51.9m +69°56'
3079		SBb	UMa	11.4	8.0'x1.9'	09h58.6m +55°57'
3077		E2/Ip	UMa	11.0	2.6'x1.9'	09h59.4m +68°58'
3184		Sc	UMa	10.5	5.5'x5.5'	10h15.2m +41°40'
3198		Sc	UMa	11.0	9.0'x3.0'	10h16.7m +45°49'
3310		I/Sc pec	UMa	11.0	3.0'x2.0'	10h35.7m +53°46'
3319		SBc	UMa	11.8	6.0'x2.8'	10h36.4m +41°56'
3359		SBc	UMa	11.0	6.0'x3.0'	10h43.4m +63°30'
3348		E1	UMa	12.0	0.9'x0.8'	10h43.5m +73°07'
3516		S0/Sa	UMa	12.4	1.0'x0.8'	11h03.4m +72°50'
3556	M108	Sc	UMa	10.8	7.8'x1.4'	11h08.7m +55°57'
3583		Sb/Sc	UMa	12.2	2.2'x1.8'	11h11.4m +48°39'
3610		E4	UMa	11.6	1.4'x0.9'	11h15.6m +46°02'
3613		E5	UMa	11.7	1.7'x0.8'	11h15.7m +58°17'
3631		Sc	UMa	11.5	4.5'x4.0'	11h18.3m +53°28'
3642		Sc	UMa	11.9	5.5'x4.2'	11h19.6m +59°21'
3665		E2/S0	UMa	12.1	1.3'x1.0'	11h22.1m +39°02'
3675		Sb	UMa	11.4	3.5'x1.3'	11h23.5m +43°52'
3690		Sp?	UMa	12.1	1.4'x0.4'	11h26.0m +58°49'
3718		SBa	UMa	11.8	3.0'x3.0'	11h29.9m +53°21'
3726		Sc	UMa	11.3	5.0'x3.4'	11h30.7m +47°19'
3729		SBp	UMa	12.5	1.8'x1.3'	11h31.0m +53°24'
3738		I	UMa	12.1	1.2'x0.9'	11h33.1m +54°48'
3756		Sc	UMa	12.3	3.4'x1.5'	11h34.1m +54°34'
3769		Sb	UMa	12.5	2.6'x0.6'	11h35.1m +48°11'
3877		Sb/Sc	UMa	12.0	4.4'x0.8'	11h43.5m +47°46'
3893		Sc	UMa	11.0	3.9'x2.5'	11h46.1m +49°00'
3898		Sa/Sb	UMa	11.9	2.6'x0.9'	11h48.7m +56°22'
3938		Sc	UMa	11.2	4.5'x4.0'	11h50.2m +44°24'
3941		E3/S0	UMa	11.3	1.9'x1.1'	11h50.3m +37°16'
3945		S0/SBa	UMa	11.9	5.0'x2.0'	11h50.6m +60°57'
3949		Sb/Sc	UMa	11.5	2.2'x1.1'	11h51.1m +48°08'
3953		SBb	UMa	11.1	6.0'x2.8'	11h51.2m +52°37'
3982		Sb	UMa	11.8	2.0'x1.8'	11h53.9m +55°24'
3992	M109	SBb	UMa	10.9	6.4'x3.5'	11h55.0m +53°39'
3998		E2/S0	UMa	11.6	1.6'x1.2'	11h55.2m +55°44'
4026		E8/S0	UMa	11.9	3.3'x0.7'	11h56.9m +51°14'
4036		E6/S0	UMa	11.6	3.0'x1.0'	11h58.9m +62°10'

NGC	M	Type	con	Mag.	Size	R.A. (1950) Dec.
4041		Sc	UMa	11.7	2.2'x1.9'	11h59.7m +62°25'
4051		Sb/Sc	UMa	11.2	4.2'x3.0'	12h00.6m +44°48'
4062		Sb/Sc	UMa	12.2	3.2'x1.0'	12h01.5m +32°10'
4088		Sb/Sc	UMa	11.1	4.7'x1.5'	12h03.0m +50°49'
4096		Sc	UMa	11.5	5.8'x1.0'	12h03.5m +47°45'
4100		Sb/Sc	UMa	11.9	4.5'x1.1'	12h03.6m +49°51'
4102		Sb	UMa	11.2	2.2'x1.2'	12h03.8m +52°59'
4111		E7	UMa	11.6	3.4'x0.8'	12h04.5m +43°21'
4138		E4	CVn	12.3	1.4'x0.8'	12h07.0m +43°58'
4143		E4	CVn	12.1	1.3'x0.8'	12h07.1m +42°49'
4144		Sc/Sd	UMa	12.4	5.3'x0.7'	12h07.5m +46°44'
4145		Sc	CVn	12.2	5.2'x3.2'	12h07.5m +40°10'
4151		SB	CVn	11.2	2.5'x1.6'	12h08.0m +39°41'
4157		Sb	UMa	12.0	6.0'x0.9'	12h08.6m +50°46'
4214		I	CVn	10.5	7.0'x4.5'	12h13.1m +36°36'
4217		Sb	CVn	11.9	4.0'x1.0'	12h13.3m +47°22'
4220		S0/Sa	CVn	12.3	2.5'x0.6'	12h13.7m +48°10'
4244		Sb	CVn	10.7	13.0'x1.0'	12h15.0m +38°05'
4258	M106	Sb	CVn	9.6	19.5'x6.5'	12h16.5m +47°35'
4346		E6	CVn	12.4	1.7'x0.7'	12h21.0m +47°16'
4369		S0/Sa	CVn	12.4	1.3'x1.2'	12h22.1m +39°39'
4395		S	CVn	11.0	10.0'x8.0'	12h23.1m +33°49'
4449		I	CVn	10.5	4.2'x3.0'	12h25.8m +44°22'
4485		E/pec	CVn	12.5	1.3'x0.7'	12h28.2m +41°58'
4490		Sc	CVn	10.1	5.0'x2.0'	12h28.3m +41°55'
4605		Sc/pec	UMa	10.9	4.0'x1.2'	12h37.8m +61°53'
4618		Sc/pec	CVn	11.2	3.0'x2.5'	12h39.2m +41°25'
4631		Sc?	CVn	9.7	12.5'x1.2'	12h39.6m +32°49'
4656		I/pec	CVn	11.0	19.5'x2.0'	12h41.6m +32°26'
4736	M94	Sb	CVn	8.9	5.0'x3.5'	12h48.6m +41°23'
4800		SB	CVn	12.2	1.2'x0.9'	12h52.4m +46°48'
4814		Sb	UMa	12.5	2.5'x2.3'	12h53.3m +58°37'
5005		Sb	CVn	10.8	4.7'x1.6'	13h08.5m +37°19'
5033		Sb	CVn	11.0	8.0'x4.0'	13h11.2m +36°51'
5055	M63	Sb	CVn	9.8	9.0'x4.0'	13h13.5m +42°17'
5194	M51	Sc	CVn	8.7	10.0'x5.5'	13h27.8m +47°27'
5195		I?	CVn	11.0	2.0'x1.5'	13h27.9m +47°31'
5204		I/Sd	UMa	11.9	3.9'x2.6'	13h28.3m +58°40'
5322		E2/E3	UMa	11.3	1.4'x1.0'	13h47.6m +60°26'
5353		E5	CVn	12.3	1.1'x0.4'	13h51.3m +40°31'
5371		Sb	CVn	11.5	3.7'x3.0'	13h53.6m +40°43'
5377		Sa	CVn	12.0	3.0'x0.6'	13h54.3m +47°27'
5448		Sa	UMa	12.3	3.5'x1.0'	14h00.9m +49°25'
5457	M101	Sc	UMa	9.0	22.0'x20.0'	14h01.4m +54°35'
5474		I/Sc/pec	UMa	11.5	4.0'x3.0'	14h03.2m +53°54'
5585		Sc/Sd	UMa	11.6	4.5'x2.3'	14h18.0m +56°57'
5631		S0/Sa	UMa	12.5	0.8'x0.8'	14h25.1m +56°48'

Martin C. Germano

The graceful barred-spiral appearance of M109 is observable with telescopes of 8- or 10-inch aperture on good nights. This shot is a 60 minute exposure on 103a-F emulsion, and was made with an 8-inch f/10 Schmidt-Cassegrain telescope.

backyard scopes. A 10th magnitude Sb spiral that occupies 9′x4′, M63 possesses a large number of kinky spiral arms that wrap around its elongated nuclear region. These are hard to trace, however, since they break up into star clouds. Using a 12-inch reflector under good skies, this galaxy appeared like a flaming pinwheel, complete with visible spiral structure. M63 probably measures 90,000 light-years across, and lies about 35 million light-years away. Its total luminosity is equal to that of about 10 billion suns, and its total mass probably equals 115 billion solar masses.

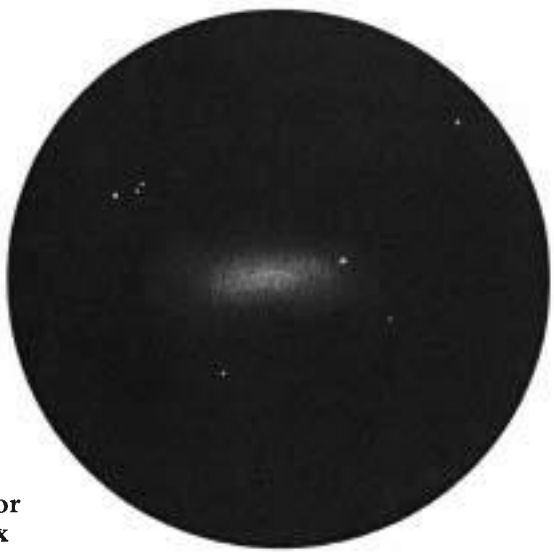
South of the M63 area lie two fainter galaxies, both of which are 11th magnitude Sb-type spirals. **NGC 5005** and **NGC 5033** are both pretty low surface brightness objects, but they measure 5′x2′ and 8′x4′ respectively, so they are interesting slivers of light on dark nights.

NGC 4631 is a large edge-on Sc-type galaxy that shows unusual signs of interaction with the much smaller NGC 4627. The strange shape and generous dust patches that pervade the big galaxy make it really fascinating in 8-inch and larger scopes. Under black skies, the 10th magnitude 13′x1′ spiral is peppered with dark splotches and a subtle haze surrounding its long thin disk. What can owners of large reflectors see in this specimen?

Stranger yet is the irregular **NGC 4656**, a huge galaxy spanning 20′x2′ and shining at magnitude 11. Thankfully the main body of the bizarre galaxy has a high surface brightness, so its "bent" shape at one end and unusual mottling can be glimpsed in telescopes as small as 6-inches aperture.

These galaxies we have looked at are just a handful of those that lie in the region of the Big Dipper. There are many more, and a few nights out with your scope and a good star atlas — either casually looking or seriously recording — will enlighten you to the great variety of form, brightness, and type. Experiment with powers, field sweeping techniques, averted vision, and even nebular filters to see which combination of equipment and technique works best for certain types of far-away galaxies. Let us at DEEP SKY know how you did with these spring galaxies: perhaps we'll publish a section of readers' thoughts, observations, and photographs in a later issue.

M63



8-inch reflector at 170x

M101

8-inch reflector at 100x

Using a Large Telescope

by Jim Meketa

During the 1960s and '70s amateur astronomers considered a 6-inch reflector to be an average scope; today's average is at least an 8-incher. Reflectors of 10-inch, 12-inch, 16-inch and even 20-inch aperture are now used by a goodly number of backyard observers.

When you buy a large scope, at first you marvel at the spiral structure and nebulous knots in M51, or gaze in wonder at an M31 that now fills more than five eyepiece fields with its mottled glow of dust lanes and HII regions. Soon, however, you will turn your big mirror toward those faint objects that were beyond the reach of your smaller scope: remote clusters of galaxies, dim planetaries lost among Milky Way field stars, or even a few incredibly distant quasars. And when you do, you will realize just how frustrating a large telescope can be.

The problem comes down to three matters: finderscopes, sky charts, and reference books. You will find that these become increasingly necessary as you turn away from the brighter, familiar objects and begin to use your large scope's ability to explore deeper into the universe.

A Large Finder

It's amazing how many amateurs struggle to locate faint objects in a 17½-inch telescope with only a 6x30 finder. In fact, several manufacturers don't even supply a finder with their large reflectors, claiming that the short focal ratios and large fields of view make them unnecessary. Balderdash! Once you've spent an hour or two aimlessly scanning here and there, you'll begin to appreciate the necessity of a large finderscope.

A good general rule of thumb is that a telescope's finder should be about one-fourth the size of the primary. Thus, a 60mm finder is adequate for a 10-inch scope, a 3-inch finder would be good for a 12½-inch, and you ought to be using at least a 4¼-inch finder on an 18-inch. Of course, there's no question that a smaller finder will work, but it will slow you down drastically.

Table 1 compares four large finders suitable for primary apertures of 10-inches or greater. The smallest, a 9 x 60 refractor, costs about $80 complete with mounting rings, and is available fully assembled and ready to use. You will have to assemble the other three

Tom Dessert

Coma I cluster

yourself from parts, although now there is one commercially available 3-inch finder. Cost, you will find, goes up rather quickly, with the parts alone for a 5-inch refractor costing about $400.

My favorite is the 4¼-inch f/4 reflector, which can be assembled from good quality components for about $125. It will reach to the limit of all but the best star charts, and does not require a separate star diagonal for easy use. All of the Messier objects and many NGC objects are immediately visible in the 4¼-inch scope's 3° field of view at 17 power. So instead of spending 10 minutes laboriously star-hopping to that faint galaxy, you can turn to it directly.

And if the cost of a large finderscope seems high, try thinking of it as a very portable small telescope!

Star Charts

With a 17½-inch primary mirror and dark, clear skies, you will find that somewhere between 20,000 and 50,000 deep-sky objects are within your reach. But to find them, you will need to know *exactly* where to look. So, along with a large finder, your next investment should be a good star atlas. Fortunately, many excellent atlases are available, and are surprisingly cheap considering the amount of information they contain and the difficulty required to gather it.

Table 2 lists six of the best atlases available for amateur deep sky observing. The *SAO Star Atlas* is out of print, but used copies can occasionally be found in second-hand book stores and often in club libraries.

Each of the 6 atlases has its own combination of advantages and disadvantages. The new *Sky Atlas 2000.0* is beautifully produced, cheap, and shows over 2,500 deep-sky objects. It is plotted to epoch 2000.0, however, making it slightly out-of-step with the vast majority of reference lists that contain positions for epoch 1950.0. (This is where a programmable pocket calculator is definitely useful.)

The *AAVSO Variable Star Atlas* is also fairly inexpensive and readily available. Based on the old *SAO Star Atlas*, it plots about 1,500 deep-sky objects and nearly four times as many stars as *Sky Atlas 2000.0*; it is produced for the epoch 1950.0. Its large scale of 4 arc minutes per millimeter is especially helpful. It does not, however, label deep-sky objects.

The large Vehrenberg *Atlas Stellarum* is the ultimate atlas for backyard observers. Its 486 offset-printed photographs of the entire sky reach fainter than magnitude 14, and are reproduced at the very large scale of 2′

per millimeter. It is expensive — well over $200 — but with it you can locate virtually any object that you can see.

And finally, there is the magnificent *Palomar Sky Survey*, produced with the 48-inch Schmidt on both red- and blue-sensitive plates. It covers the entire sky in 6°x6° plates down to -33° declination. The scale is huge, 1.1′ per millimeter, and stars and galaxies fainter than magnitude 21 are clearly visible.

Few amateurs seem to realize it, but individual *Palomar Survey* prints are sold through the mail by the Caltech bookstore for about $3.50 each. While a complete set of E and Oh:0 prints currently runs $8,000, you might find that you can live with a partial set, say just those covering the center of the Virgo Cluster, for example. Write the Cal Tech bookstore (1-51 San Pasqual St., Pasadena, CA 91125) for ordering instructions and a free catalog.

One point to consider when choosing a star atlas is that plate scale is more important that limiting magnitude. The field of view with a 25mm eyepiece on a 17½-inch f/4.5 telescope is 0.6°, or 36 arc minutes. On the *Sky Atlas 2000.0*, this corresponds to a tiny circle 4.4mm in diameter, not much larger than the brighter stars! On the *Atlas Stellarum* the same field is about 19mm in diameter, almost exactly the size of a penny. A diameter of 19mm isn't huge, but at least you can get a clear sense of what the eyepiece field should look like.

Table 1: A Comparison of Large Finders

Size	Type	FOV[1]	Power[2]	Relative Light Grasp[3]	Approx. Limit Mag.
9 x 60mm	refractor	3.5°	9x	1x	12.3 m
3-inch f/5	refractor	3.8°	12x	1.6x	12.8 m
4¼-inch f/4	reflector	2.9°	17x	2.5x	13.3 m
5-inch f/5	refractor	2.3°	20x	4.4x	13.8 m

1. Field of view assumes a 25mm eyepiece with apparent field of 50° for the 4¼-inch reflector, and a 32mm eyepiece with 45° apparent field for the two large refractors. The 9 x 60 FOV is as stated by the manufacturers.
2. At these powers, all four finders will offer an exit pupil of approximately 6.4mm.
3. For the refractors, a 90% transmission efficiency is assumed. For the reflector, an 88% reflection efficiency at each mirror less a 1.3-inch central obstruction is assumed.

Table 2: A Comparison of Common Star Atlases

Atlas	Limit Mag.	Scale	Comments
Sky Atlas 2000.0 Field Edition	8.0 m	8.4′/mm	26 charts showing 43,000 stars and 2,500 deep sky objects.
SAO Star Atlas	9.5 m	7′/mm	152 charts showing 260,000 stars and virtually all NGC and IC objects. Out of print.
AAVSO Variable Star Atlas	9.5 m	4′/mm	178 charts with 260,000 stars, about 1,500 deep sky objects, and over 2,000 variable stars.
Atlas Borealis, Eclipticalis and Australis	9.5 m	3′/mm	80 charts with 320,000 stars but *no* deep sky objects. Stars are color-coded to indicate spectral class.
Atlas Stellarum	14.0 m+	2′/mm	486 offset printed charts of actual sky photographs.
Palomar Sky Survey	21.0 m+	1.1′/mm	936 pairs of photographic prints covering the entire sky to −33° declination. Individual 6°x6° prints can be purchased.

Reference Books

With an aperture of 10-inch or greater, you will see many objects that are not plotted on any star atlas. Where *Sky Atlas 2000.0* shows two galaxies, for example, your eyepiece may reveal five or ten. In order to identify these objects, you will need to consult some form of catalog.

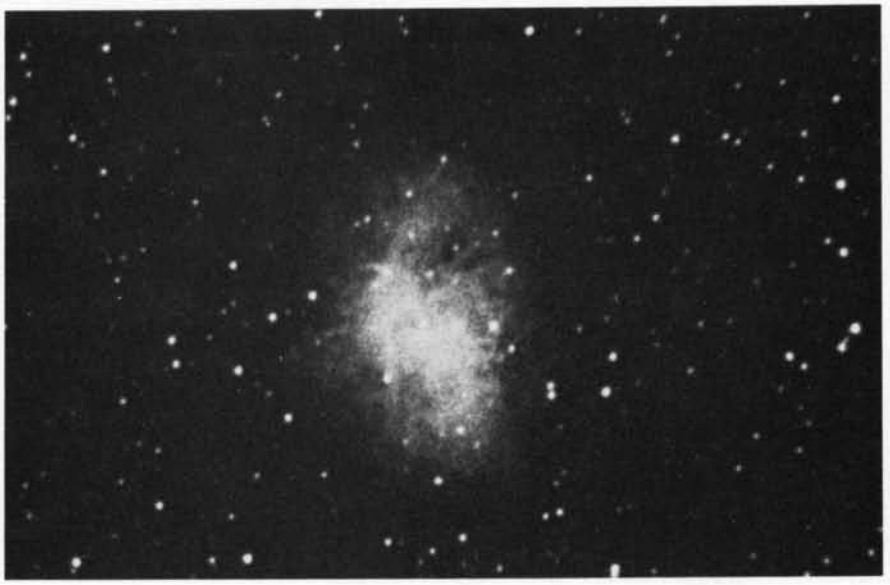
Virtually all of the astronomical research conducted since the time of Galileo has been spent in locating, measuring and recording deep-sky objects. Astronomy is, after all, primarily an observational discipline. As a result, there are dozens of lengthy catalogs and lists of objects, but unfortunately, very few are designed for amateur use.

The following list contains those reference works that are most likely to be of use. Many can be purchased from specialty book dealers, and virtually all of them should be available in a large public or university library.

General References

Burnham's Celestial Handbook, Robert Burnham Jr., Dover Publications, 3 vol. An invaluable reference, listing thousands of deep-sky objects, variables and double stars. Contains many fine photographs and much useful background information. Organized by constellation, with all positions given to epoch 1950.0. Probably the best single reference catalog available.

The Revised New General Catalogue of Nonstellar Astronomical Objects, Jack W. Sulentic and William G. Tifft, University of Arizona Press. Lists all 7840 objects in the original *New General Catalogue* in RA order using a computer output. Two brief descriptions, the magnitude and the 1975.0 position are given for each object. The 1975.0 epoch is inconvenient, but this single volume represents a fairly complete list of the



Martin C. Germano

The Crab Nebula

nonstellar deep sky objects brighter than magnitude 14.

Webb Society Deep-Sky Observer's Handbooks, Kenneth Glyn Jones, editor, Enslow Publishers, 5 vols. The only significant reference books written by amateur observers specifically for amateur observers. The 5 volumes are:

Volume 1 — 522 double stars

Volume 2 — 89 planetary and 90 gaseous nebulae

Volume 3 — 268 open and globular clusters

Volume 4 — 275 galaxies

Volume 5 — clusters of galaxies

Each volume is divided into two parts. An opening section, which may be more than half the volume, summarizes our current understanding of these objects in moderately technical language. The remainder of each volume consists of eyepiece descriptions and careful drawings made by amateurs using instruments from 1-inch to 100-inches. Positions are given for various epochs (1950, 1975, and 2000) and each volume is organized by RA. The contents are eclectic, and each volume contains a nice mixture of easy and difficult objects. They are not exhaustive but excellent reference volumes full of useful facts.

Handbook of the Constellations, Hans Vehrenberg and Dieter Blank, Treugesell-Verlag. A richly produced survey of the heavens, organized by constellation and with positions to epoch 1950.0. For each constellation there is a white-star-on-black sky chart to magnitude 6, with a detailed list of objects on the overleaf. Where they exist, many of the following are tabulated: bright stars, double stars, variable stars, galactic clusters, globular clusters, planetary nebulae and galaxies. This book is the least-complete general index of objects, since the cut-off magnitude for deep-sky objects is about 11, and only the brightest double stars are mentioned.

A Master List of Nonstellar Optical Astronomical Objects, Robert S. Dixon and George Sonneborn, Ohio State University Press. This is a valuable item for owners of large scopes; it contains some 185,000 entries of deep-sky objects from 270 catalogs, and thus is the most complete list of its kind. It provides 1950.0 coordinates, magnitudes, diameters, and short descriptions of everything from the Andromeda Galaxy to 18th magnitude "faint blue objects."

All five of these reference works are in print and readily available from scientific book houses. In a future article, we'll look at some even more interesting items, the specialized lists maintained by professional astronomers.

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Gamma Cygni Nebulosity

Al Lilge

Exploring Open Clusters in Canis Major and Puppis

by Brian Skiff

The rich constellations of **Canis Major** and **Puppis** lie in the southern winter sky for northern observers. Both constellations hold examples of every type of deep-sky object, though clusters dominate and galaxies are largely obscured by intervening Milky Way star clouds. Canis Major does contain at least a dozen reasonably bright galaxies, but we will mention only one here. The region is on the meridian right after dark on March evenings, and is notable for having little of the obscuring dust and gas found in other sections of the Milky Way. Because of this relative transparency you can even see very faint galaxies right on the galactic plane in central Puppis, and more than 150 open clusters have been discovered in the two constellations.

Our first object is a naked eye cluster in Canis Major, **Messier 41** (or NGC 2287). The cluster is so big and bright that a modest pair of binoculars will resolve it, and a 2.4-inch refractor will show about 30 stars at low power. The 6.1 magnitude blue star 12 CMa lies on the southeast side and a conspicuous band of fainter stars lines the northwest periphery. About 50 stars, ranging in magnitude from 8 to 12, are shown by 6-inch apertures within a 30′ area. With a 10-incher you can trace outlying stars to a 45′ diameter and many pairs can be seen.

By sweeping your scope eastward at about the same declination, you can find many fainter but still interesting clusters. Just northeast of a 6.6 magnitude star (the double star ADS 5692; magnitudes 6.6 and 10.6; 5.2° separation in position angle 143°) is **Tombaugh 1**, first reported in 1938 by Clyde Tombaugh, discoverer of Pluto. It is a moderately faint cluster for a 10-inch scope. About 20 stars of 12th magnitude and fainter are resolved at high power, the stars being concentrated within an apparent diameter of 6′.

About 45′ southeast is another cluster that Tombaugh found on plates taken with the 13-inch astrograph at Lowell Observatory. **Tombaugh 2** has a very different character than To 1. In a 10-inch at low to medium powers, it appears as a 3′ diameter fuzzy spot. At 190x I could just barely resolve it into a few magnitude 13 to 14 stars — which may be only field stars anyway. The glow is quite uniformly smooth, indicative of very faint stars. On the *Palomar Sky Survey* print of the area, the cluster is very compact and very rich — so much so that the faint stars give the impression of a globular cluster. Since the professionals haven't yet made a study of the cluster, it's hard to say much about it. But I'll venture a guess that it is among the class of older evolved clusters with many yellow giant stars and that it lies at a great distance from the Sun.

About a degree to the south, a catalogue entry identifies **Ruprecht 9**. I couldn't see anything looking like a cluster here in a 10-inch Newtonian, nor is there any obvious cluster at the location on the Palomar chart. **Ru 10**, however, which is farther east, is composed of a chain of stars nearly 20′ long. In the 10-inch the chain is strung out in p.a. 165° and has about two dozen stars of magnitude 11 to 13 in it. **Ru 11** is a group of about 15 stars of 11th and 12th magnitude in an irregular arrangement elongated north/south. Two-thirds of the members are clumped on the north side, including a pair at the north end (approximately 20′ separation in p.a. 45°). The cluster stands out from the general field by the nearly equal magnitudes of its member-stars. **Haffner 4** appears as a large haze of low surface brightness perhaps 15′ across. Some magnitude 12 and fainter stars overlie the haze as seen in my 10-inch.

Plotted as a quadruple star on the *Atlas Eclipticalis* is a deep-sky object, **NGC 2367**. A very nice cluster in the 10-inch at low powers, it is dominated by a fairly bright double star (magnitudes 9.4 and 9.7; separation 6′ in p.a. 270°). The concentrated clot of stars measures 10′ x 5′ in extent; I counted 18 stars at 125x. A dark area surrounds the cluster at low power, and the *Eclipticalis* shows few stars here as well. About 7′ north is a small group of four stars in the dark zone, but this nevertheless seems to be an appendage to the main cluster.

A degree and a half to the northeast lies a pair of small clusters, **NGC 2383** and **NGC 2384**. The first is somewhat larger and more populous than the second, and is pretty conspicuous in a 10-inch. Concentrated into a 5′ area are at least 20 stars, mostly magnitude 11 and fainter. However, three 10th magnitude stars straddle the cluster. Vogt and Moffat (see references at end) give the following V magnitudes for these stars, going east to west: 9.77, 9.92, and 9.76 (the last should appear orange-red). In the same field, NGC 2384 includes a closer pair (magnitudes 9.0 and 9.6; separation 5′ in p.a. 350°). A small collection of about eight stars east of the pair comprises the entire cluster. You'll find a mangitude 8.6 star farther east. Vogt and Moffat discovered that although the clusters are only 8′ apart in the sky, they are not physically related; NGC 2384 lies half again more distant.

A little south is a cluster called **Ru 19**. In the 10-inch I noted some concentration of field stars, but nothing I'd really call a cluster. Fields in the vicinity are delightfully rich, but can be confusing when you attempt to identify sparse and ill-defined clusters.

Skirting the border with Puppis to the east is another pair of clusters, these discovered by Trumpler. Conspicuous at low power is **Tr 7**, which is dominated

Facing page: Brian Skiff made this photo of objects in Puppis using the 13-inch f/5 "Pluto" Camera at Lowell Observatory. The exposure was made on 103a-O emulsion and lasted for 25 minutes. The scale is about 27.9′/inch.

by a string of stars aligned southeast/northwest, and includes two double stars near its center and a faint triple at the northwest end. Vogt and Moffat give V magnitudes of 12.27, 10.76, and 12.74 for the triple; for the wider pair just southeast of the 9th magnitude bright star in the middle of the string the magnitudes are 11.22 and 11.58; the position angle 50°. The whole string is 10′ to 12′ long and the 10-inch scope shows 25 stars in the immediate area. **Tr 6** is a poor, weakly concentrated cluster — much fainter than Tr 7 — and not really interesting in a 10-incher. You'll see about 20 stars of 11th magnitude and fainter in a 6′ area.

Continuing our jog back south and west, we come upon an enchanting object, **NGC 2362**, which surrounds the naked-eye star Tau (τ) CMa. A 2.5-inch refractor will resolve 15 stars around the overpoweringly bright 4th magnitude central star. In a 6-inch the fainter stars all seem very blue. A 10-inch reveals two close companions to the central star: Hartung gives their magnitudes as 10.0 with an 8′ separation in position angle 90°, and 11.2, 14′, 78°. He also mentions that they are resolvable in a 3-inch "with close attention." The beautiful covey of stars around Tau is delineated by a triangular form pointing south (Tau being a bit eccentric to the north) and a total of 50 stars are visible, mostly evenly spread, but with some close groups.

A much larger cluster is **NGC 2354**. A 2.4-inch shows four groups in the area; the richest, on the west, is the cluster with a dozen stars; the others are poorer and contain only three to five stars each. The 10-inch shows a loose, irregularly gathered cluster. A small concentrated group of about 15 stars in 7′ diameter on the west spreads south and east to a more extensive group — it becomes hard to tell what constitutes the actual cluster, which is perhaps 40′ diameter overall.

Ru 18 is a pretty nice cluster in a 10-inch, and appears as an unconcentrated group of 25 stars in 5′ diameter at 95x. A brighter magnitude 10.5 star lies on the southwest side, while the cluster stars are mostly of magnitude 11.5 and fainter.

As promised, even this close to the plane of the Milky Way, you can find a galaxy! **NGC 2380**, however, is barely visible at low power in a 10-inch. At 190x it looks like an unresolved globular cluster — a high surface brightness patch at most 30′ across. Boris Vorontsov-Velyaminov included it in his *Morphological Catalogue of Galaxies*

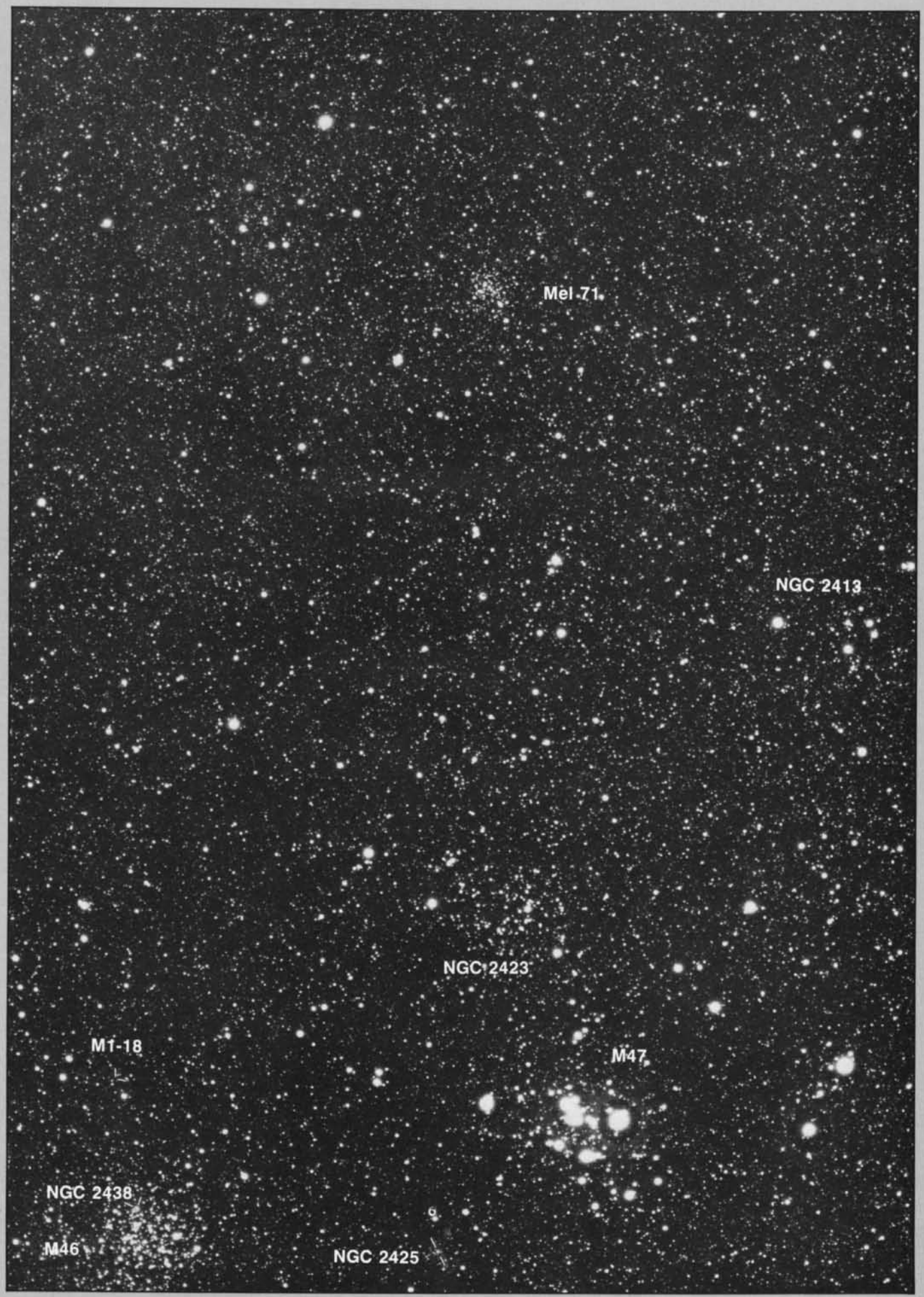
Objects in Canis Major and Puppis

Name	RA (1950)	Dec.	Diam.	V	*s	Type	Notes
⊙ NGC 2287	6h 44.9m	−20°41′	38′	4.5	69	II3m	=M41, 1
⊙ To 1	6 58.2	20 24	6	9	—	III2m	
⊙ Ru 9	6 59.8	21 51	1.4	?	—	II1m	
⊙ To 2	7 01.2	20 47	3.0	11	—	I3m	
⊙ Ru 10	7 04.2	20 02	4.5	9	—	IV2p	
⊙ Ru 11	7 05.2	20 43	2.9	9	—	III2p	
⊙ NGC 2354	7 12.2	25 39	20	6.5	297	III2m	2
⊙ Ha 5	7 16.0	22 34	5	10	—	III2p	
⊙ NGC 2362	7 16.7	24 51	8	4.1	69	I3p	= τCMa, 3
⊙ NGC 2367	7 18.0	21 50	3.5	7.9:	15	IV3p	4
() NGC 2380	7 21.8	27 26	0.5	13.5	—	E	5
⊙ NGC 2383	7 22.6	20 50	6	8.4:	11	I3m	4
⊙ Ru 18	7 22.7	26 07	4.0	9.4:	20	III2p	6
⊙ NGC 2384	7 22.9	20 56	2.5	7.4	15	IV3p	4
⊙ Ru 19	7 23.5	21 25	8	8	—	IV2p	
⊙ Tr 6	7 24.0	24 12	6	9	—	III2p	
⊙ Tr 7	7 25.2	23 56	2.6	7.9	16	II3p	4
⊙ NGC 2396	7 25.8	11 38	10	7	—	III3p	
⊙ NGC 2401	7 27.1	13 52	2.0	11	—	II3p	
⊙ Ru 24	7 29.6	12 39	2.0	8	—	III1p	
⊙ NGC 2413	7 30.9	13 00	10	7	—	—	7
⊙ NGC 2414	7 31.0	15 20	4.0	7.9	27	I3m	8
⊙ NGC 2422	7 34.3	14 23	30	4.4	117	III2m	=M47, 9
⊙ NGC 2423	7 34.8	13 45	19	6.7	86	IV2m	10
⊙ Ru 26	7 34.9	15 32	10	8	—	IV2p	
⊙ Mel 71	7 35.2	11 57	9	7.1	216	II1m	11
⊙ Mel 72	7 36.0	10 34	9	8	—	II1p	
⊙ NGC 2425	7 36.0	14 45	3.3	8	—	III2p	
⊙ NGC 2437	7 39.5	14 42	27	6.1	186	III2m	=M46, 12
■ NGC 2438	7 39.6	14 37	73″ x 68″				13
■ M1-18	7 39.7	14 15	31″ x 30″				14

Notes:
1 — Feinstein, Cabrera, and Claria 1978. Astr. & Ap. Suppl. 34:241.
2 — Durbeck 1960. Zeit. fur Ap. 49:214.
3 — Mermilliod 1976. Astr. & Ap. Suppl. 24:159. most of the data, in this case, are drawn from Johnson and Morgan 1953. Ap. J. 117:313.
4 — Vogt and Moffat "I" 1972. Astr. & Ap. Suppl. 7:133.
5 — V-V gives dimensions 0.5′x0.5′ and photographic magnitude 13.5.
6 — Moffat and Vogt "IV" 1975. Astr. & Ap. Suppl. 20:85.
7 — not a cluster. Diam. is estimated value from observation.
8 — FitzGerald and Moffat 1980. PASP 92:489.
9 — Smyth and Nandy 1962. Pub. Royal Obs. Edinburgh 3:2; and Hoag et al 1961. Pub. U.S. Naval Obs. 17, part 7.
10 — Smyth and Nandy 1962, plus a few stars from Eggen 1979. Ap. J. 234:168.
11 — Hassan 1976. Astr. & Ap. Suppl. 26:9.
12 — Smyth and Nandy 1962.
13 — dimension from Perek and Kohoutek's 1967 Catalogue of Galactic Planetary Nebulae. J. Kaler (1976 Ap. J. 210:113) gives a magnitude for the central star of B=15.0.
14 — dimension from Perek and Kohoutek 1967. They also list a central star photographic magnitude of 19.0.

Gosta Lynga's *Catalogue of Open Cluster Data*, June 1981 microfiche edition, is the source for positions, diameters and Trumpler types for all open clusters. "V" lists visual magnitudes determined from the sum of the number of stars given under "*s". Values with a colon (:) are approximate, due to an insufficient number of measured stars. Sources of data for each cluster are given in the notes. Magnitudes given only to whole values are my estimates based visual observations and the appearance of the clusters on photographs, and should be regarded as preliminary. For some of the double/multiple stars, the data come from the Lick Observatory *Index of Double Stars*, while for others it comes from the papers listed in the notes.

⊙ = open cluster ■ = planetary nebula () = elliptical galaxy


Mel 71
NGC 2413
NGC 2423
M1-18
M47
NGC 2438
M46
NGC 2425

Using his 8-inch SCT at f/5 and 103a-F emulsion, Bill Iburg recorded this image of M46 and planetary nebula NGC 2438. The exposure lasted 35 minutes, and was developed in D-19.

and classified it as an elliptical — a look at the *Sky Survey* print seems to confirm this. His photographic magnitude of 13.5 seems a little faint (the *RNGC* lists 13.0, which is an interpretive error in reading the *MGC*). Hartung observed it from Australia, and found it just visible with an 8-inch stop over his 12-inch Newtonian.

Two fine Messier clusters serve as starting points for exploring northwestern Puppis. **Messier 47**, or NGC 2422, is also a naked-eye object and includes a bright orange star on its west side. This star is the triple system Σ1120 (magnitudes 5.7, 12.2, and 9.1; separations 5.2′ and 19.6′ at p.a. 176° and 36°). Small aperture scopes will show the wider and brighter pair in this system. Another more equal pair, Σ1121, lies near the center of the cluster. In a 2.4-inch about 30 stars can be counted in the irregular assemblage, with an arm of stars extending northward. Some colors are discernible in the brighter members with a 6-inch and a total of 50 stars is shown. In a recent observation with the 10-inch, I counted 80 stars within an area 45′ across.

NGC 2423 is an oft-overlooked cluster lying only 35′ north of M47. In a 2.4-inch about two dozen stars are resolved in this fairly rich object. A conspicuous 9th magnitude star shines near the center. The number of stars increases gradually with aperture. With a 12-incher about 60 stars, including some close pairs and a few faintly red stars, are seen in a 13′ circle. The bright star near the center is the double system ADS 6223, which has magnitudes of 9.6 and 9.7, and a separation of 7.3′ in p.a. 299°; the brighter component has a very close companion at 10.2 magnitude half a second of arc away in p.a. 159°.

Just southeast of M47 is another small cluster, **NGC 2425**. This fairly faint object is elongated east and west and has an extent of about 5′x2′. With a 10-inch scope you can see at least 20 stars, and a crossbar of stars caps the east end.

Another degree east lies the companion to M47, **Messier 46**, or NGC 2437. Rather different than M47, this fascinating cluster contains many faint stars. Despite their faintness, the broad patch can be partially resolved in a 2.4-inch at only 25x with averted vision; a magnitude 8.7 star stands out on the west side. At 45x and 90x this aperture shows many evenly distributed stars and the planetary nebula **NGC 2438** suspended in the north side of the cluster. A magnitude 11.2 star appears on the southeast edge of the nebula. With a 10-inch, the cluster shows perhaps 150 stars in an area 30′ across. Near the center there is a "hole" with only a few faint stars in it.

The planetary (NGC 2438) is close to 1′ in diameter and is annular. A 12th magnitude star appears a little west of its center. In a 12-inch at 440x, the nebula appears to be elongated in p.a. 120° with its acute ends being somewhat fainter. A magnitude 14.3 star is on the north side of the soft grey nebula. A dark patch observed near the 11th magnitude star to the southeast could merely be a contrast effect.

As it happens, the planetary is *not* a member of the cluster, but rather lies in the far background. Estimates of the visual magnitude of the nebula range from 9.3 to 11.0, while Vorontsov-Velyaminov gives a photographic magnitude of 11.3 in a study published in back 1931 — the most recent value given in the planetary nebula catalogue of Perek and Kohoutek.

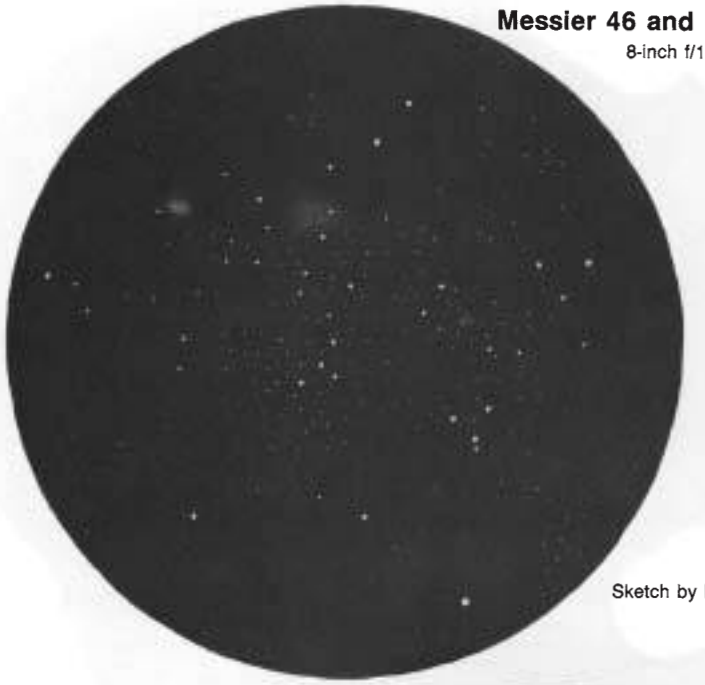
The planetary nebula **M1-18**, discovered by Minkowski in 1946, lies not far north of M46, and should be visible in larger instruments. I have looked for it once, but failed to see it, probably because I wasn't looking in the right place. It lies about 2′ northeast of a magnitude 8.5 star shown on the *Atlas Eclipticalis*. On the *Sky Survey* photo it seems of rather high surface brightness, with a total magnitude of perhaps 13. It would be good to hear from readers who observe this object.

South of M47 is a moderately faint cluster, **Ru 26**. In the 10-inch it is weakly concentrated and does not stand out from the field — several 10th magnitude stars to the north are distracting. About 25 stars are visible in a haziness about 8′ in diameter. A 9th magnitude star appears on the east edge. One degree to the west is **NGC 2414**, which contains a bright central star of magnitude 8.2. In my 10-inch the object consists of 12 to 15 stars of magnitude 12 and fainter in a string 3′ long running east and west. South of the bright star I noted a faint pair (magnitudes 12.4 and 12.5; separation 6″ in p.a. 120°).

NGC 2410 is a very compact cluster that is not visible in a 6-inch instrument. With a 10-inch it is not overly conspicuous at 95x, and at 190x it appears as a faint irregularly shaped haze 1.5′ across in which are embedded four or five magnitude 13.5 stars. The edge of the cluster is well-defined.

Spilling over into Canis Major is the widespread cluster **NGC 2396**. A good object for smaller apertures and wide fields, this cluster lies southeast of a 5.8 magnitude star (ADS 6104: 5.8 and 9.5 magnitudes; 23.2″ separation in p.a. 157°). Though it may be only a random clumping and not a true cluster, the stars range from 9th to 11th magnitude and should be a good sight in a small refractor or high-power binoculars. With the 10-inch I saw about 40 stars scattered over an area 40′ diameter. To the east, **Ru 24** is a moderately easy cluster in a 10-inch, and you can't help wondering why it was passed over by the Herschels. The stars are fairly bright, from magnitude 11.5 on down, and three 10th magnitude stars form an 8′ triangle across the 12′ diameter cluster that contains about 30 stars.

Nearby, the *NGC* shows another cluster, **NGC 2413**, which is a poor and inconspicuous group not considered to be a true physical association by the



Messier 46 and NGC 2438
8-inch f/10 SCT at 100x

Sketch by David J. Eicher

Messier 47
8-inch f/10 SCT at 100x

Sketch by David J. Eicher

professional astronomers. My 10-incher shows two clumps in a 10′ area: on the north are several widespread stars of magnitude 9 to 11, while on the south side is a small group of magnitude 11 and 12 stars.

Heading northeast you find two nice clusters first reported by Melotte in 1915. His survey was based on an examination of the Franklin-Adams photographic star atlas. The first cluster, **Mel 71**, is in Puppis. In a 2.4-inch scope it can be seen as an unresolved smudge at low powers. A narrow south-pointing triangle of stars lies on the southwest edge. At 45x a few stars can be resolved. The cluster is fairly bright in a 10-inch with about 50 stars of 11th magnitude and fainter visible in a circular uncondensed area. The triangle star closest to the center of the cluster is a double (8′ separation in p.a. 115°). With a 12-inch, the cluster has an 8′ diameter, and within this area lie some 60 stars including a small knot in the center.

About 1.3° north, just over the border into Monoceros, is **Mel 72**. Fainter than Mel 71, it is barely visible at 45x in a 2.4-inch refractor. Six-inch and 10-inch scopes reveal the triangular outline of this rich cluster, which points approximately north. At the southeast and southwest edges of the cluster is a slightly brighter star. In a 12-inch about 35 stars are shown, with more stars appearing to the west side of the triangle's base.

Farther south in Puppis lie several dozen clusters, many of them faint ones discovered in the last thirty years. They've been neglected by amateurs for too long! In later issues, we'll talk about many of them in detail. Pick the next clear night and, armed with your trusty star atlas, take a trip south!

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Double Stars

The Finest Double Stars of Spring

by Glenn F. Chaple, Jr.

Rare indeed is the telescope buff who can gaze at double stars and not be captivated by their beauty. Though they lack the prestige of Messier and NGC objects, double stars are nevertheless a source of delight and wonder to a growing number of deep-sky observers.

As you know, the previous issue of DEEP SKY marked the beginning of a new era for this publication. To tie things together for those of you who followed this column in the old DSM and to welcome new readers, I outlined in DS #1 some basics of double star observing for both beginning and advanced skywatchers. Here and the next three issues, we'll continue our general overview by examining 100 of the finest double and multiple stars in the heavens — 25 for each season. So, let's get those telescopes out and tackle our spring offering.

All of the stars chosen lie within a wedge of sky between 8h and 14h in right ascension and north of −40° declination. You'll probably find that a thorough star atlas such as Tirion's *Sky Atlas 2000.0* is a real help, but as most of the stars on the list are bright, any atlas will probably suffice. Here goes!

Zeta (ζ) **Cancri** (magnitudes 5.6, 5.9, and 6.0, separations 0.8″ and 5.7″, position angles 280° and 81°). A double star in small scopes, Zeta Cnc becomes a triple if you use an 8-inch when skies are steady. The closer pair is a binary with a 59.6-year period, widening to 1.2″ separation by the year 2020. How many of you big-scope owners can resolve this grand triple?

Phi² (ϕ^2) **Cancri** (mags. 6.3 and 6.3, sep. 5.1″; p.a. 218°). There's something almost hypnotic about the cat's-eye gleam of an equally bright pair like this. Phi² makes an ideal test object for an 1-inch scope; the pair is located about 10° east of Pollux.

Iota¹ (ι^1) **Cancri** (mags. 4.2 and 6.6, sep. 30.5″; p.a. 307°). Iota¹ is a beautiful yellow and blue combination that reminds you of Albireo. It is a fine object for telescopes of any aperture. Forty minutes of arc to the southwest lies

Σ1266 (mags. 8.0 and 9.2, sep. 23.4″, p.a. 64°).

Iota² (ι²) **Cancri** (mags. 6.1, 6.6, and 9.2, seps. 1.5″ and 55.6″, p.a. 318° and 199°). This triple star, also known as 57 Cnc, lies 2° northeast of Iota¹ Cnc. Observers with 3-inch telescopes may care to use the main pair as a test of their instrument's resolution. Both stars display a fine golden yellow hue.

38 Lyncis (mags. 3.9 and 6.6; sep. 2.8″, p.a. 229°). What a beautiful double! I have seen them split in a 3-inch when the seeing was good. I suggest you use at least 100x on them. Can you see a third component of 11th magnitude, situated 88″ away in a position angle of 212°?

23 Ursae Majoris (mags. 3.8 and 9.0, sep. 22.7″, p.a. 270°). Despite this pair's being so wide, they are difficult for a small scope to split due to the large magnitude difference between the two components. They seem to have a third companion about 11th magnitude lying 100″ away to southwest, but it is probably only an "optical" pairing.

Zeta¹ (ζ¹) **Antliae** (mags. 6.3 and 7.2, sep. 8.2″, p.a. 211°). I threw this in since it is a beautiful pair despite its being rather southerly. Both stars have A-type (white) spectra, and lie in the same field of view with the star Zeta² Antliae.

Alpha (α) **Leonis** (mags. 1.3 and 7.6, sep. 177″, p.a. 307°). The brighter object is the well-known star Regulus. Despite the large separation between Regulus and its companion, the two stars share the same proper motion and it is therefore very likely that they form a gravitationally-bound system. When you observe the fainter component of an unequal pair like this, you will often see it display an unusual oscillatory motion when you jiggle the telescope tube back and forth in a direction perpendicular to a line joining the two stars. Try it!

Gamma (γ) **Leonis** (mags. 2.6 and 3.8, sep. 4.3″, p.a. 123°). Known as Algeiba, this binary system has an uncertain period — perhaps 6 or 7 centuries long. It is a grand pair, though their current separation will require magnifications in excess of 100x for a comfortable view. Some observers have likened it to a pair of car headlights a long distance away down a foggy road. Its double nature was discovered by William Herschel in 1782, and its present separation will gradually widen to about 5″ by the early 22nd century.

35 Sextantis (mags. 6.3 and 7.4, sep. 6.4″, p.a. 236°). A fine showpiece in an otherwise obscure constellation. Both stars have a K-type spectrum, which ought to result in a golden yellow or orange hue. But as the famed 19th century observer T. W. Webb noted, there is "much diff. as to colours." What do you see?

Xi (ξ) **Ursae Majoris** (mags. 4.3 and 4.8, sep. 2.6″, p.a. 98°). This is a beautiful, swift-moving binary system that will close down to 0.8″ separation (in p.a. 359°) about a decade from now. Until then, keep a watch on the pair and see how long you can continue to separate them. Historically important as the first binary star to have its orbit computed has a period of 59.7 years.

Mizar (right) and Alcor

Sketch by Glenn F. Chaple, Jr.
2.5-inch f/10 reflector at 80x

88 Leonis (mags. 6.4 and 8.6, sep. 15.4″, p.a. 328°). This pair lies roughly midway between Beta and Theta Leo in the Lion's hindquarters. Some observers report seeing a bluish tinge in the fainter star, although it has a K-type spectrum — a seeming discrepancy that is probably a result of the brightness contrast with the primary star.

N Hydrae (mags. 5.8 and 5.9, sep. 9.1″, p.a. 210°). This star appears in very old books as 17 Crateris; after the IAU redefined all the constellation boundaries in 1930, the star "moved over" to Hydra. Observers in northerly latitudes usually don't see this beautiful matched set at its best; its far-southerly position usually leaves it a victim to whatever atmospheric distortions fall to your lot while you observe.

90 Leonis (mags. 6.0 and 7.4, sep. 3.4″, p.a. 208°). A little over 2° north and slightly east of 88 Leo, this delicate-looking pair can be resolved in small scopes when the atmosphere is steady. Try powers of 100x or so.

2 Canum Venaticorum (mags 5.9 and 8.2, sep. 11.4″, p.a. 260°). Look 4° west of Beta CVn for this pretty double star. Its component stars form an interesting spectral combination (M1 and F7) — or reddish and yellowish. In addition, a two-magnitude difference in brightness between them has led to a lot of disagreement among observers as to the colors perceived in an eyepiece. What's *your* opinion?

4 Ursae Majoris (mags. 9.0 and 9.3, sep. 50.1″, p.a. 83°). Why include such a faint and wide pair in this list? Simple — it's a Messier object! Knowing that a nebulous object had been reported near Delta UMa, the great French comet-hunter searched the area, but to no avail. He did find this rather dim pair, however, and for reasons we can now only guess at, entered it as the 40th object in his catalog.

Delta (δ) **Corvi** (mags. 3.1 and 8.4, sep. 24.2″, p.a. 214°). Delta is an easy "test" for small instruments — similar to (but not as difficult as) 23 UMa. If you can't see the companion directly, try averting your gaze slightly to one side. This allows the light to fall on a more sensitive part of your retina, and is often the only way to perceive faint objects that lie on the threshold of visibility.

24 Comae Berenices (mags. 5.2 and 6.7, sep. 20.3″, p.a. 271°). This double system makes a colorful yellow and blue combination. It lies a few degrees south of the Coma star cluster. Just for fun, when you find it scan 2° to the west and you'll see the 10th magnitude elliptical galaxy, M85.

Σ1669 (mags. 6.0 and 6.1, sep. 5.4″, p.a. 309°). Located in Corvus, Σ1669 is a fine example of the more than 3100 double stars cataloged by F. G. W. Struve in the mid-1820's. Many bright pairs bear "Σ" designations, including several on this list. (For example, Zeta Cnc is also Σ1196 and Phi² Cnc is Σ1223.) A striking set of near-twin stars, Σ1669 lies 4° northeast of Delta Crv and just 1.5° south of 8th magnitude M104, the Sombrero Galaxy.

Gamma (γ) **Virginis** (mags. 3.6 and 3.6, sep. 3.9″, p.a. 297°). Known as Porrima, Gamma Vir is one of the most celebrated binary systems. Since its

discovery as a binary by James Bradley and James Pound in 1718, Porrima has completed over 1½ revolutions. Its orbital motion will cause it to close to a minimum separation of just 0.4″ by the year 2008. Twins in brightness and spectral class (F0), its component stars both appear slightly yellowish.

Σ1694 (mags. 5.3 and 5.8, sep. 21.6″, p.a. 326°). Situated in Camelopardus, this lovely circumpolar pair consists of two stars of spectral class A. (Despite being a rather indistinct constellation, Camelopardus nevertheless claims a number of fine doubles.)

Alpha (α) **Canum Venaticorum** (mags. 2.9 and 5.4, sep. 19.6″, p.a. 228°). This star, named Cor Caroli ("the heart of Charles"), is one of the finest double stars in the sky for small telescopes. The colors displayed by these spectral class A0 and F0 stars are rather subtle and thus often carry names that are more a product of the observer's whims than of reality. To me, they looked bluish-white and yellowish when viewed with a 13-inch reflector. Do you agree? While you're here, also take a look just ½° to the east where you'll find the faint, but still pretty, pair Σ1702 (mags. 8.0 and 8.5, sep. 35.6″, p.a. 83°).

Theta (θ) **Virginis** (mags. 4.4 and 9.0, sep. 7.1″, p.a. 343°). This double is a tough test for 3-inch scopes — you'll see it better in a 6-incher or larger. Another faint companion (at magnitude 10) lies 71″ away in p.a. 299°.

Zeta (ζ) **Ursae Majoris** (mags. 2.4 and 4.0, sep 14.4″, p.a. 151°). Well-known as Mizar, this star at the bend of the Big Dipper's handle is also undoubtedly the finest double star for beginners due to its brightness, ample separation, and ease of finding. Zeta was the first double star to be discovered with the telescope (by Giovanni Riccioli in 1650). It was also the first to be photographed (by George P. Bond in 1857), and it was the first star to reveal that it had a spectroscopic companion (Mizar A, found by Edward C. Pickering in 1889). Mizar forms a naked-eye double pair with 4th magnitude Alcor, located 12′ to the east. A grand sight at just 30x!

k Centauri (mags. 4.7 and 6.2, sep. 7.9, p.a. 108°). Also known as 3 Cen, this double star is a fine pair of spectral type B stars. When you observe it, you'll find that like the other southerly pairs Zeta Ant and N Hya, it is greatly subject to atmospheric turbulence.

* * *

Well, it's great to be back doin' this column again after a layoff of almost 6 months. As always, I welcome reader comments — even if you write to chew me out for leaving out your favorite spring double star!

82 South Harbor Road
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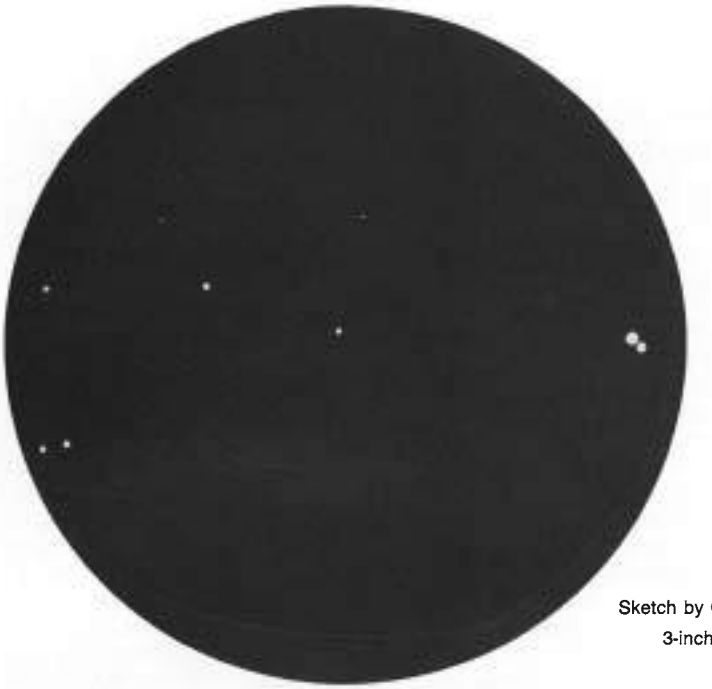
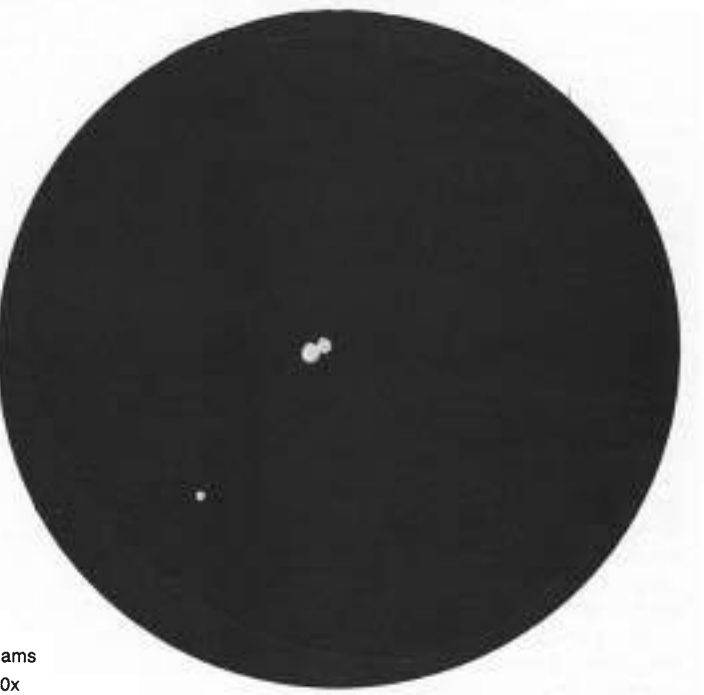


Cor Caroli
Sketch by Glenn F. Chaple, Jr.
3-inch f/10 reflector at 60x

γ Leonis John Sanford



γ Leonis
Sketch by Debra J. Williams
4-inch f/4 reflector at 150x

The Challenge of Variable Star Observing

by David H. Levy

In this column last issue, I gave some basic hints on the technique of variable star observing in this issue, I am going to explain more of the fundamentals and suggest a couple of simple programs to get beginners started — and some of you older hands might like to brush up your technique.

* * *

Besides interest, what else do you need? Although you can observe some variables with the naked eye and follow dozens more with just a pair of binoculars, you'll find that a telescope is essential for observing most variables. It need not be equatorially mounted; all that really counts is your being familiar with using it. The actual observing procedure is simple: estimate the brightness of your program star — the variable — to a tenth of a magnitude by comparing it with nearby stars of constant brightness whose magnitudes have been determined.

How do you know these magnitudes? The national clearing-house for variable star observation, the American Association of Variable Star Observers — better known as the AAVSO — has compiled charts which tabulate the magnitudes of the main stars in the same field of view as the variable. These charts are available for a nominal fee (25 ¢ each) from the AAVSO. Write them for a list (and inquire about membership while you're at it); their address is 187 Concord Avenue, Cambridge, MA 02138.

The most common kind of variable is the long period or Mira kind (so-named after the prototype). These vary by several magnitudes over a leisurely interval of about 200 to 400 days. Other variables are not so regular: large semi-regular stars, often bright enough to see with binoculars, will vary by small amounts over shorter but less-certain periods. Some variables, such as SS Cygni, explode periodically; others, like R Coronae Borealis, undergo completely irregular and sudden drops in brightness.

In general, the following is a good guide to how often you should check in on the different types of variables. Long period or Mira stars: every two weeks. Semi-regular stars: every two weeks to once a month. Eclipsing: for those with sharp minima (like Algol), make several estimates while a minimum is in progress. Cepheids: depending on length of period, check them once a night to once a week. Dwarf novae: look in on them every night, unless the star is going into outburst — check it every few hours then. R Coronae Borealis: once a night — you never know when one of these stars will begin its plunge to minimum.

The Steps in Observing a Variable Star

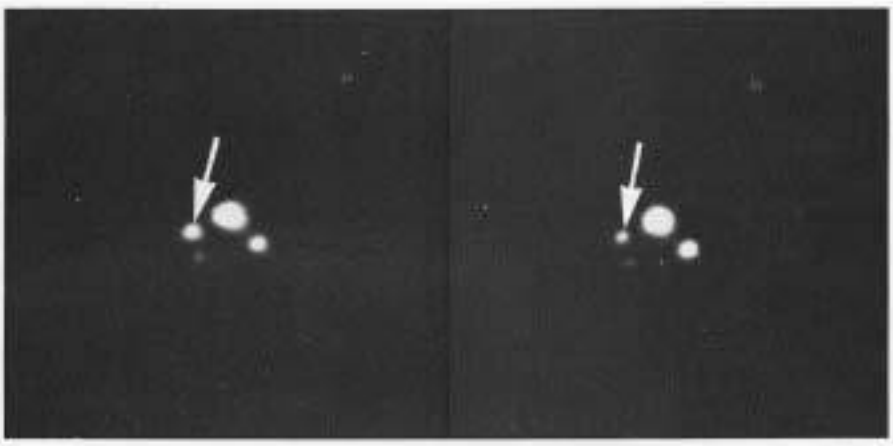
1. Find the variable. Don't laugh! This can be the single most difficult step in the whole process, especially for beginners, and it is probably the main reason why many new observers quit observing variables. The remedy? Go easy. Variable stars are elusive: they lack the easily-discerned disc of a planet or the fuzziness of a cluster or galaxy. Many variables, though by no means all, have "late" spectra (K and M) and are reddish in color; this can be the tip-off.

2. Choose two comparison stars, one which is brighter and the other fainter than your perception of how bright the variable is. Let's say the star's magnitude lies between two standard stars whose brightnesses are listed as 7.2 and 7.8. If, on close checking, you think the star is about a third of the way down from the brighter star, then note its magnitude as 7.4.

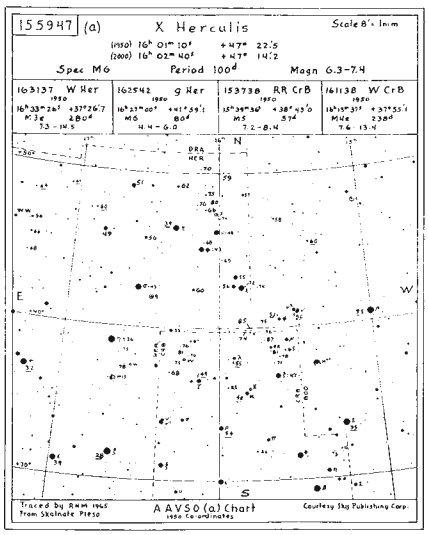
3. Record your estimate, marking down the instrument and eyepiece power you used along with the date and time.

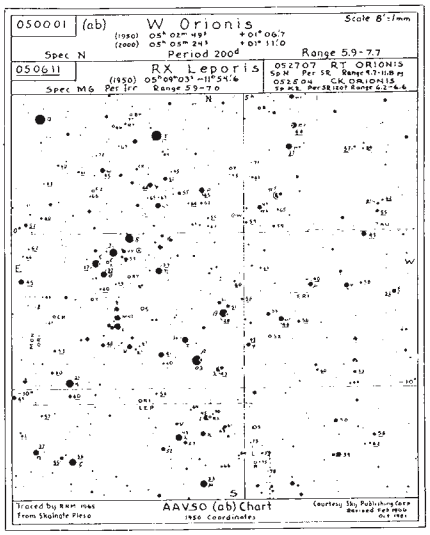
The first time I ever estimated a variable star, I came away resolved never to look at one again. The star for the evening was Chi Cygni, a Mira-type star which at maximum light adds a star to the neck of Cygnus the Swan. Since I was new to observing variables, I hadn't seen the annual predictions list that the AAVSO issues. As a result I didn't know that at the particular time I was observing, Chi Cygni would be far, far less bright than its 5th magnitude maximum.

After two hours of frustrated hunting through swarms of faint Milky Way stars, I finally found a very unobtrusive Chi Cyg hovering at magnitude 12.8. The moral? If you don't find the star, keep at it, since persistance will usually pay off. (It is also a good idea to check



David Hudgins used a 10-inch f/5.6 Newtonian and 10 second exposures on Tri-X film to produce these two images of θ^1 Orionis. Note that the left photo shows star A at normal light output, while the right photo shows it at a minimum.





American Assn. of Variable Star Observers

the AAVSO predictions; some stars really are below your magnitude limit and should be left alone — unless they are dwarf novae or lie in a field you know well.)

Two Observing Programs

To get started making actual observations, order the chart for X Herculis from the AAVSO (ask for the "A" chart). Besides X Her, the chart also has two other variables on it as well, g Her and RR CrB. Using the comparison magnitudes shown on the chart, estimate each star's brightness twice a month. Then, along with estimates made by your friends, plot the changes in brightness for each star as the weeks pass. Soon you will be able to draw smoothed lines through the points — these will be the stars' "light curves" and the shape of the curve is characteristic for each type of variable.

X Her and its companions are summer-month objects; for the winter months, send away for the "AB" chart on W Orionis. This is a yellowish, semi-regular variable that changes from 6.5 magnitude down to 10th magnitude; its "period" is about 210 days — but remember, it is a semi-regular star, so its changes in brightness have a way of surprising you. Also included on the chart is RX Leoporis, a very red star that has some interesting variations. Make your estimates of these stars' brightnesses every two weeks.

The beauty of these two simple programs is that you can follow them completely with nothing more sophisticated than binoculars. Though interesting for experienced observers, they are still not too difficult for beginners.

Cataclysmic Variables

While the Mira (long-period) stars often display some variation in period from cycle to cycle, eruptive variables — the dwarf novae — are often completely irregular. Naturally, this penchant for the unexpected has attracted many observers to them — you never know what you are going to see on any given night. In addition, the recent discovery of X-ray emission from one of them has generated intense interest among the professional astronomers. As a result, these stars deserve a top priority on any observing program.

SS Cygni is the most popular example of a dwarf nova. Like the rest of its type, it is a double star system in which one star transfers matter from itself to the other star. About once every 50 days or so, when this matter falls onto the surface of the receiving star, it heats up and produces a small explosion and a flare of light. The uncertainty in the period is one of the factors that makes these stars so exciting to watch. On one occasion, only two weeks elapsed between the end of one eruption and the start of the next, and on another, I watched SS Cyg slumber quietly while two months dragged by.

Some outbursts are sudden: you watch in wonder as a tiny 12th magnitude point of light brightens over the course of a few hours by almost four magnitudes. Other outbursts take more time: I have watched SS Cyg for a week while it struggled up to its maximum brightness, hovering every now and then at intermediate levels on the way.

SS Cyg is a good eruptive variable to follow. The AAVSO has four charts that cover its range; a good starter set would be the "B" and "D" charts. If you want a complete set, order the "C" and "E" as well (there is no "A" chart). A 3-inch scope can follow SS Cyg part of the way to minimum light, though a 6-inch is needed to see it when it gets there. If you turn your scope to where SS Cyg ought to be, but you see nothing, then record this fact by logging the magnitude of the faintest star you can see. For example, if the faintest star were at 10.8 magnitude, the notation would read "(10.8." The "(" means the variable was below the magnitude noted.

If on the next night's observing, you see that a 10th magnitude speck of light has made its appearance, you know that something is going on.

* * *

Variable stars have a magic to them: you can observe stars passing through eruptions and inconsistencies — or you can visit and draw comfort from the slow beat of the long-period variables. You watch fascinated as a dwarf nova cries out in a flash of light and you look with curiosity at old novae that rest peacefully as time passes by.

Every year new variables are discovered and much more is learned about how these stars behave. Quite possibly your own observations may help to add to this knowledge.

And when each of your observing sessions is over and you finally come inside for that now-welcome mug of hot chocolate, you bring with you more than just the knowledge scribbled on the pages of your logbook. Out in the cold night air, you and your telescope acquired a sense of community with the sky.

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Eight Ways to Muff A Variable Star Estimate

Clouds: Not the nice kind that cover the whole sky, because those will simply keep you indoors — I mean those little scattered clouds that seem to park themselves in front of all your favorite variables. And, in accordance with some supreme law, just as you pack up to go indoors, the clouds thin out and disappear.

Wind: A windy night can be even more devastating than clouds. Having set up your scope, there you stand, battling the breeze to keep it on its mounting. Gusts of wind bring tears to your eyes and while blinking furiously to clear them, you hunker down closer to the eyepiece — which promptly fogs up.

The Police: You are desperate to observe R CrB before it sets over that house across the way. With one hand focusing the eyepiece and the other clutching a note pad, you make your estimate just as the boys in blue arrive to check out a "Peeping Tom" complaint.

Sheer Brainlessness: You and your telescope have just arrived at a dark-sky site 37 miles up a dirt road. You unpack and discover you left the carry-box of eyepieces at home.

The Neighbors: Your carefully planned observing session degrades into a guided sky-tour for all the neighbors' kids, who, having scented "neat stuff" from a block away, descend in droves on your doorstep. (N.B., this is especially prevalent in campgrounds.)

The Cat: One night I was looking at some faint variables in Orion when all of a sudden the field of view and the telescope simply disappeared. The top of the tube was pointing to the ground — the #%$&! cat had jumped up for a look.

Lights: The night your neighbor has his college reunion party with 200 people and 16 specially-installed flood lights will be the same night that you miss a long-awaited outburst of SS Cygni.

Little Kids: In the spirit of purest good will, you let your 4-year-old nephew Jason examine your telescope. Later that evening as you go to observe R Leonis, the gummy feel of the eyepiece tells just how enthralled he was with the experience.

An Interview with Richard Berry

During the first week of August 1982, I traveled to Milwaukee on business, part of which involved the negotiation that led to *Deep Sky Monthly* becoming DEEP SKY magazine. During my five day stay, I arranged to interview Richard Berry, editor of ASTRONOMY and TELESCOPE MAKING, in his northwest Milwaukee house. We talked about his life, his observing interests, the state of deep-sky astronomy, and various AstroMedia publications. Here is part of what we said:

DSM: How did you get into astronomy?

Berry: I was a very, very near-sighted kid, so the whole world amounted to what existed within two feet of my nose, and preferably within six inches. I guess I was in 5th or 6th grade when I finally got glasses — all of a sudden I could see things, like robins pulling worms out of the ground, that I hadn't known were happening before. Among the "new" phenomena were stars in the sky. I became interested in constellations and in observing and began using binoculars to try to see things like Jupiter's moons.

At some point I remembered that years earlier my Dad had built a telescope. I asked him where it was and he said it was up in the attic. Off we went to the attic and dragged this thing out, all full of dust and grime. So we washed off the mirror, and although it was cracked, I tried to use it (after all, any segment of a parabolic mirror forms an image just like the whole mirror does). At that time — 1960 — Jupiter and Saturn were very close together in the southern sky, so I pointed the scope at them — it was the greatest thing in the world! I went back the next night and the jovian moons were in a different position. Saturn was just a magnificent little jewel — I was totally entranced.

DSM: So your first telescopic views of the universe were made from a fragment of a mirror.

Berry: Oh yes. It was about 60 percent of a 6-inch. It had been broken in the aluminizing process. The coating was 15 to 20 years old, and probably 10 or 15 percent reflective. But my Dad had started work on a new mirror, and had gotten as far as #600 grit in fine grinding. I ended up polishing it, and in about two months, I had what I thought was a perfect mirror. It turned out to be about 400 percent corrected, so I went back again, and this time did it right. In fact the mirror is the one that's in that telescope downstairs.

DSM: So you were a telescope maker right from the start.

Berry: Well, it was the only way I could get a telescope. It's been an economic motivation — never had the cash to buy a telescope, so I've always made them. The year after I finished the 6-inch, I asked for an 8-inch mirror kit for Christmas and I got it. I made an 8-inch f/10, next a 6-inch f/4, then a 12-inch f/7, which has been written up in TELESCOPE MAKING.

"People are once again looking for a challenge — doing more meaningful stuff than simply duplicating someone else's achievements."

DSM: Were you as active an observer as you were a telescope maker?

Berry: I was much more active as an observer than a telescope maker. Telescope-making supported the observing hobby. I loved optics, but grinding a mirror was the only way I could have afforded a 12-inch telescope. Back in 1963, remember, a 12-inch telescope was a big telescope — *really* big stuff for a high school kid.

DSM: Did you get involved in astronomy meetings?

Berry: Not long after getting my first telescope going, I joined the Fairfield County Junior Astronomical Society in Stamford, Connecticut. My Dad would also take me to meetings of the "seniors," the Fairfield County Astronomical Society. In 1962, one of the older men in the club, George Dobsloff, offered to drive me and a couple other kids up to Stellafane; we camped out in George's car. It was wonderful: we saw all of the telescopes, all of the people, sat in the dark and listened to what Walter Scott Houston had to say about the world.

DSM: How did you get interested in writing about sky objects?

Berry: Well, as I said, I was a "blind" kid, very near-sighted — I'd always read a lot. And I think writing is a natural thing to follow. When I joined the junior astronomy club they didn't have a newsletter, so a friend and I decided to put one out. We called it *The Star Monthly*. It was a 4-page thing done on a mimeograph machine. Another friend would take them to the senior meetings and sell them for a dime, which kept us going. We put it out for three years, on borrowed and donated materials.

DSM: And now you're writing a book.

Berry: Yes, the book came out of TELESCOPE MAKING magazine. One of the editors at Charles Scribner's Sons wanted to know if I'd be interested in doing a book on some aspect of telescope making. I wrote them back a letter and said, "I'm busy; I don't have time...well, let me think about it." A month later I wrote back and said, "I've thought about it and there hasn't been a good beginners book on telescope making in English for some years!"

People getting started in telescope making today are exposed to archaic methods. I got sort of excited about the idea, wrote them a proposal which they accepted, and they sent me a contract. Now I'm writing the book. It's one of these things you almost fall into.

DSM: What are your favorite things in

the sky to observe?

Berry: It's been different things at different times. When I was in high school, planetary observing was my favorite. The 8-inch f/10 telescope had extraordinarily good optics, and a very, very slight paraboloid. I observed two

Tim Wells

"Going out and looking at deep-sky objects is enjoyable and it's the thing that continues to drive me."

apparitions of Mars, and did some astrophotography, even though it lacked a clock drive. I found most of the Messier objects with the 6-inch and later observed them again with the 12-inch.

I didn't have a telescope all through college and for about two years afterward. I had moved away from home, gotten married, and was scraping along doing odd jobs. But a good friend, Bill Morrow, and I put together a 2.4-inch reflector, and after looking through it, I realized I'd forgotten how much fun observing is. Bill moved out into the country, and my wife Ele and I would go out there to visit.

At some point, my younger brothers took pity on me, stuffed all my old telescope mirrors into the trunk of the car, and drove out to visit me. They brought my 12-inch mirror and a couple of 6-inchers, and all of a sudden I was an astronomer again. For the first time in my life I began to spend a fair amount of time under a dark sky, and I quite literally "discovered" the Milky Way. You know about it from books, but if you've never seen it well and then *do* see it, it can be pretty exciting. Bill and I started to take wide-angle pictures, using a 50mm lens and Tri-X film.

DSM: So then you had big mirrors with which to view the Milky Way.

Berry: Well, actually, I put off using the big mirrors for a few years. I had a site where I could observe. I cleaned up the 4-inch f/6 Aero-Tessar lens which I'd bought years earlier, built a large box for it and made a great big camera which could take 4x5-inch and 8x10-inch sheet films. I started photographing the Milky Way, and my interest in deep-sky observing progressed. I did something that almost nobody else that I knew in astronomy was doing. I was observing very, very wide-field phenomena. I was totally entranced when I discovered Barnard's *Atlas of Selected Regions* — somebody had been there 65 years earlier than I had been. Having become the editor of ASTRONOMY and being exposed to so much work by many other people, I realize that a lot of the stuff I was doing has been done much better by others. Now I very happily devote a lot of my efforts to helping other people bring their work out before the public.

DSM: Would you say that deep-sky observing is now your primary interest?

Berry: Yes, fired by the interest in the Milky Way, and made possible by my 20-inch telescope.

DSM: Do you have any favorite nebulae or galaxies?

Berry: Before I had the 20-inch, my favorite object was the edge-on galaxy NGC 4565. It's just an incredibly thin little spike. But with the 20-inch, I'm more excited by the Veil Nebula — which is phenomenal, because I can now see detail in it. And it's quite bright, especially with a good light-pollution filter. But another object that I'm really fond of, mainly because I had never seen it before building the 20-inch, are the little reflection nebulosities near Gamma (γ) Cassiopeiae, IC 59 and IC 63. They are dim little things. In terms of showing other people — M13 is great, even if there is a Quarter Moon in the sky. It makes people say, "Wow!"

DSM: How do you see observing *vs.* photography?

Berry: Astrophography is kind of funny: it was the "in" activity among amateurs some years ago and is still being done a great deal. But it's increasingly hard to be a "star" in astrophotography; and to be good at it compared to what you see published in ASTRONOMY, *Sky and Telescope* or DEEP SKY takes a tremendous effort. I think people are shifting their emphasis toward activities that require less fancy equipment — activities they can be more directly involved in. And certainly you can be directly involved in looking at deep-sky objects.

DSM: Because for the first time, faint objects can be both big and bright.

Berry: And satisfying. You look at them and there's enough image there that you can *see* the spirality in the galaxy. You can see its core and, in the case of something weird like M64, you can make out dust lanes. Your imagination can work on images like that; it's a spine-tingling experience.

DSM: Do you think people worry too much about mirror size and not enough about first-class skies? When I was down at the Texas Star Party, using a 12-inch telescope, we saw spiral arms in many Messier galaxies; in a similar size scope where I lived in Ohio, the same objects were fuzzy blobs.

Berry: To some extent, but people don't have much control over their location. If I could observe from anywhere I wanted, I would probably choose a place like Mauna Kea. Then we'd pass out from lack of oxygen, or perish in one of their famous blizzards. Nothing beats a good site — I've had some of the best observing runs of my life from the island of Kauai and the big island of Hawaii. There I saw the zodiacal band all around the sky. Using a 4-inch Astroscan, I probably had the most exciting observing session I've ever had. Of

Tim Wells

"I suspect astrophotography is running out of gas...you can buy a set of slides of the Messier list, so why spend two or three years shooting your own?"

course it would have been wonderful to have had the 20-inch there, but the site is incredibly important.

DSM: Being the editor of ASTRONOMY and living in downtown Milwaukee, do you get the chance to observe as much as you'd like?

Berry: To make good use of the 20-inch telescope, you would have to go about 100 to 120 miles to the northwest of Milwaukee. My uncle has a cabin on the upper peninsula of Michigan which I've been to only twice. It has utterly phenomenal skies.

DSM: Good observing sounds like a rarer experience that you'd like it to be.

Berry: Oh, yes. Not only that, but the job impinges. If I were an ordinary amateur astronomer, I would certainly get in more observing. This summer, for instance, I attended the Astronomical League convention which was held at the dark of the Moon, and Stellafane, also held at the dark of the Moon. I've been to Riverside, which interferred with my being able to use the dark Moon before that. The result is that out of maybe six possible New Moons during the summer, perhaps two of them will be clouded out, and three more will be during trips — which leaves me about one good chance to fool around with the telescope all summer long!

DSM: Do you miss the observing much?

Berry: When I go to Riverside or Stellafane, I get to use other people's telescopes, and at Riverside, it's definitely a jump upward in aperture. You meet so many people and have such a good time that it compensates. I'm certainly not dying for lack of looking through a telescope.

At home, I do a lot of observing from the yard with 4-inch and 6-inch telescopes. Much of it is what I call "ground-truth" observing. Our readers often have 4-inch, 6-inch, and 8-inch telescopes, and I'm trying to find out whether specific things we're saying in articles, or whether things I'm thinking about writing in articles, are in fact true. Can you really see three saturnian satellites with a 4-inch telescope? Can you really see Cassini's division right across the ring when the inclination is what it is now? Is the Red Spot still red or has it turned pale? One of the ways to find this out is to observe on a regular enough basis that you keep things monitored.

DSM: What are your goals as Editor of ASTRONOMY?

Berry: My goal is to make ASTRONOMY better. There are a lot of ways in which it can improve: I want to make it more accurate and more authoritative, without losing its readability. The crucial thing is balance. It's easy to pile on the authoritative stuff, but then you have a big, indigestible mass that is dull and hard-to-read.

DSM: Is it possible to maintain an astronomy magazine that is both easy to read for beginners and also valuable for more experienced observers?

Berry: I think so — if you avoid a textbook approach to questions, and work with scientists who understand their material. Anyone can take familiar material and rehash it in a dull way. It's a standard thing for club newsletters to run an article on the Hertzsprung-Russell diagram that adds nothing new to the subject. What I look for is something that signals me that the author has insight into the nature of the thing. A lot of it lies in the approach.

DSM: It's a matter of obtaining writers who can interpret?

Composite photo by Richard Berry

Berry: Yes. I look for astronomers who don't think in the same old ruts. The best people, I find, are relatively young astronomers who are still teaching undergraduate students. They are still aware of how the average non-scientific person's mind functions. And of course the top people are superb writers. They are always clear thinkers, and always good writers.

DSM: The Bart Boks and Carl Sagans.

Berry: Yes.

DSM: How do you select articles for ASTRONOMY?

Berry: We have several different ways. People submit articles, and if we are interested in the topic, we use them. Sometimes we have a subject we'd like to do a story on, and we'll ask an astronomer to write it. We also go to conferences, professional and amateur, and listen to the talks. If someone has a gift for presenting material clearly, we ask him to do a story. We also ask professionals to work on an article involving their research specialty. The department articles work about the same way, excepting that we tend to write more stuff ourselves. We get a lot of useful input from readers who want to know how to do something in astrophotography, how to watch an upcoming eclipse, and so on.

DSM: That brings me to the subject of repetition. Obviously some basic material on a subject must be rehashed eventually. It's tough to do that, isn't it?

Berry: ASTRONOMY has grown incredibly in the last three years. So with new readers coming in wanting to know certain things, the old readers suffer slightly. Again, the trick in avoiding boredom is presentation. Not just doing a rehash, but carefully rethinking the subject so that you introduce new insights. Even to somebody who already knows how to photograph meteors, you can write an article that will suggest new ideas.

DSM: How do design ideas emerge at ASTRONOMY?

Berry: For feature articles we always ask the author to provide as much graphic support as he possibly can. Often these guys will have pictures of galaxies or diagrams of something that we might not have seen before. We then sit down together — the art director, the editor who's working on the story, and I — and compile an exhaustive listing of everything we can think of that might be at all relevant to the story. You can have the main story, sidebars and boxes that add to it, tables, diagrams, pictures — whatever. We then eliminate the least essential elements, one by one. At this point we allot an article so much space in the magazine. The trick is to make sure that everything that goes in counts: everything has to have a reason for being there.

DSM: Can you think of any particularly outstanding articles in the history of ASTRONOMY — ones that really impressed you the most?

Berry: The stories which I've enjoyed doing most are probably the Voyager Jupiter and Saturn flyby articles. And I certainly enjoyed working on Jack Marling's article on the skies of Mauna Kea. I've done so many issues now that I can't keep them all in mind!

DSM: How do you evaluate issues of ASTRONOMY?

Berry: You work on them so closely and

thoroughly that there is a sort of "post-issue depression." The new issue comes out and the very thought of looking at it makes you sick.

I usually get bound copies of the magazine on a Wednesday or a Thursday. I take them home and hide them somewhere. Along about Sunday, I'll throw one on the coffee table and say to myself, "Oh, wow, my ASTRONOMY magazine just came!" Then I'll try to look through the magazine as if I were a reader. I'll say, "Yuck, this thing disappoints me", or "This is good," or "I like that" — I try to be objective. Then I'll go to work on Monday and say "Hey, what did you think of the issue?" People in the office say, "Jeez, I didn't like the cover at first, but it's kind of grown on me." Or: "That green and purple on page 10 looks just disgusting," and I'll sort-of agree that the green and purple on page 10 *does* look kind of disgusting.

We haven't been doing formal critiques of issues, but we do hold an informal one. And six months later, we'll sometimes sit down with a stack of a dozen magazines and go through them. I'll say "Well, I thought that article really stank when we did it," but I can now look at it with fresher eyes, and find it really had some things going for it that I hadn't seen.

DSM: You must be quite satisfied with the progress of the magazine, both in terms of contents and graphics.

Berry: It's been satisfying and it's become better — and a lot of that is due to other people than myself. I think our art director, in terms of the magazine's looks, deserves more credit than anybody else. In terms of the copy quality, we've sure tightened up, which comes from experience.

DSM: What plans do you have for AstroMedia in the coming months and years?

Berry: We're very interested in book publishing, although it may not turn out to be feasible. I very much would like to see us become involved in doing an amateur astronomer's newsletter. Something to unite all the amateur astronomers all over the United States would be a unique publication. Neither *Sky and Telescope* nor ASTRONOMY really cover this topic: everything from neat articles about the history of astronomy to interviews with people — all sorts of things.

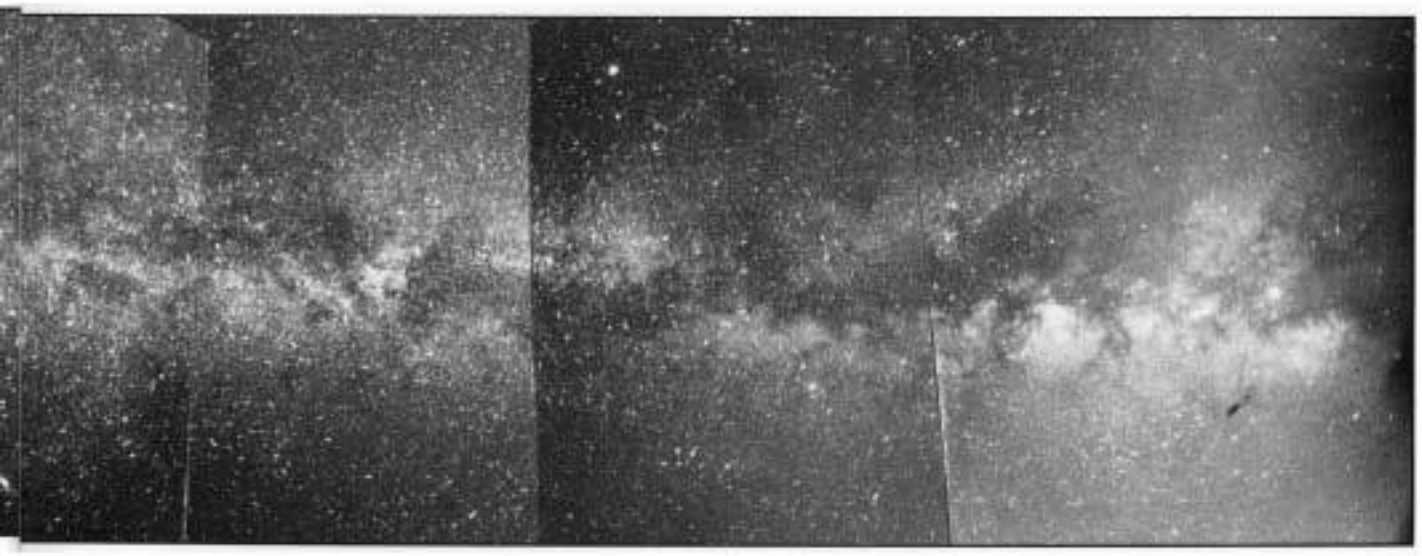
I'd like to include good, up-to-the-minute observing information, and charts that are large and comfortable. I think that this publication, which I envision as a tabloid-size newspaper coming every two weeks, could revolutionize and inspire amateur astronomy in the United States more than anything else. When *Star & Sky* came along a few years ago, it could have filled the need, but not enough people wanted yet another glossy color magazine — so *Star & Sky* missed the boat.

DSM: Over the last few years there have been several specialty programs in amateur astronomy, including Problicom, the AAVSO, the IAPPP, and a supernova watch. These are important achievements, but do they detract from the usefulness of simply going out and *looking* at deep-sky objects?

Berry: Oh, no! Going out and looking at deep-sky objects is *enjoyable* and it's the thing that continues to drive me. The great bulk of people want to relax and stay acquainted with the universe, but don't have the interest or time to get involved in a long, and perhaps expensive, systematic program. But these programs offer ambitious people somewhere to go; a chance to excel.

DSM: How do you think amateur astronomy will progress in the '80s?

Berry: That's a fascinating question, but I don't really have any answers. I *am* looking. I read a lot of club newsletters, go to quite a few meetings, and stay close to amateurs through TELESCOPE MAKING. In a sense, amateur astronomy is reaching the point of maturing. In the 1960s, when I was in high school and college, most of an amateur's effort was devoted to overcoming simple technical problems. For example, if you wanted to take astrophotos, you had to try to get a good drive, find out how to do guiding, and



try to get decent film. You were fighting the very basics of getting things done.

DSM: And it's different now?

Berry: Certainly. Nowadays, you can buy a C-11, stick it on a Byers 812 mount, get a Lumicon off-axis guider, and be in business doing really high grade astrophotography on either chilled color emulsions or fine grain hydrogen-hypersensitized black and white emulsions.

You can start off doing stuff that would have taken 5 to 10 years to build up to in the '60s — excepting in the '60s the color films that could do the job didn't even exist. This makes it easy to do top grade work, but it removes some of the challenge that motivates people.

What you are left with is doing something more meaningful, finding that challenge again. I suspect astrophotography is running out of gas. You can now go out and buy a complete slide set of the Messier list, in color, done on a C-14. Why should you spend 2 or 3 years duplicating that on your own, if you can go out and buy it. So the question is, what are you going to do? A sensible person might say, "Rather than duplicating Ben Mayer's slide set, I'll spend my time doing something more useful, perhaps photometry or joining the AAVSO and making magnitude estimates."

People are once again looking for a challenge: doing more meaningful stuff than simply duplicating someone else's achievements.

— Dave Eicher

The Curious Case of Copeland's Septet

At one time — I'm not sure just when — I ran across a reference to a group of galaxies called "Copeland's Septet." I noted the group's position and plotted it on chart VIII of my old *Atlas Eclipticalis*. In March of last year, I happened to be observing in northern Leo and decided to look in on the group. Swinging my 10-inch Newtonian toward the spot, I put on high powers and after a little searching was able to see something. As its name suggests, the Septet carries seven NGC numbers, but since I saw only a few objects, I decided to check out the *Palomar Observatory Sky Survey* photos of the area.

Well, sure enough, there they all were on the appropriate *Sky Survey* print — a knot of interacting elliptical and spiral galaxies. I overlaid a mylar grid which showed SAO stars and deep-sky objects listed in the *Master List of Non-Stellar Astronomical Objects* of Dixon and Sonneborn. But the overlay was cluttered to the point of illegibility: the bright and rich cluster of galaxies Abell 1367 lies not far to the southeast, and a multitude of legends for the individual galaxies within it overwhelmed the small group. It was hard to tell just what was what.

All the same I could see designations from Zwicky's *Catalogue of Galaxies and Clusters of Galaxies (CGCG)* and Vorontsov-Velyaminov's *Morphological Catalogue of Galaxies (MCG)* clustered on the overlay around the group; since these listings usually identify objects with NGC numbers, I turned to them hoping to identify the objects I saw. But although both listed objects at the right position, neither made cross-reference to the NGC. To add to the confusion, the galaxies are clearly identified in the *Second Reference Catalogue of Bright Galaxies (RC2)* by de Vaucouleurs, de Vaucouleurs, and Corwin. To help resolve my growing puzzlement, I wrote a friend who lives in Colorado, Alexander Brownlee, and asked him to try an exposure of the field with his 16-inch Newtonian.

By return mail I got a copy of a letter Brownlee had written to Jack Sulentic (co-author of the *Revised New General*

Basic Data for Copeland's Septet (source: RC2)

Name (NGC)	RA (1950)	Dec.	Dimen.	Type
3746	11h 35 12m	+22° 17.2′	1.35′ x 0.71	SB(r)b
3745	35 13	18.0′	0.41 x 0.23	SB(s)O-:
3748	35 21	18.2′	0.76 x 0.30	SBO?sp
3750	35 25	15.1′	0.91 x 0.72	SABO-?
3751	35 29	12.9′	0.41 x 0.30	SO-:pec
3753	35 29	15.6′	2.04 x 0.63	Sb?sppec
3754	35 30	15.7′	0.44 x 0.36	SBb?pec

Identifications to Other Catalogs

NGC	MCG	UGC	CGCG (vol. II, pp 176 and 180)
3745	4-28-4	—	—
3746	4-28-5	6597	11 35.1+22 17, mag. 15.3
3748	4-28-7	—	11 35.2+22 18, mag. 15.5
3750	4-28-8	—	11 35.3+22 15, mag. 15.2
3751	4-28-9	6601*	—
3753	4-28-10	6602	
3754	4-28-11	—	11 35.4+22 16, mag. 14.6

*UGC 6601 coordinates are incorrect in UGC.

Corrected Information for the RNGC:

NGC	TYPE	RA (1975)	Dec.	X	Y	Mag.	Ref.	Notes
3745	5	11 36.4	22 10	320	115	15.0	3	V*, A320
3746	5	11 36.4	22 09	320	114	15.5	2	Z,V*, A320
3748	5	11 36.5	22 10	319	115	15.5	2	Z,V*, A320
3750	5	11 36.5	22 07	319	112	15.0	2	Z,V, A320
3751	5	11 36.6	22 05	318	110	15.0	3	V
3753	5	11 36.6	22 08	318	113	15.0	2	Z*,V*, A320
3754	5	11 36.6	22 08	318	113	15.0	2	Z*,V*, A320

Sources:

Burbidge, M. and W. Sargent, in *Nuclei of Galaxies*, 1971, p. 351.

Dreyer, J. L.E., *Notes to the First Index Catalogue*, p. 282 of the 1962 reprint by the Royal Astronomical Society.

Hickson, Paul, "Systematic Properties of Compact Groups of Galaxies." *Ap. J.***255**, p. 382 (15 April 1982).

Using a 16-inch f/5 Newtonian Telescope and hypersensitized TP 2415 emulsion, K. Alexander Brownlee photographed Copeland's Septet.

Catalogue) and Robert Dixon (co-author of the *Master List*) which pointed out errors in both volumes with regard to the identities of the Copeland's Septet galaxies. Both Sulentic and Dixon essentially said that the objects do not exist! Brownlee argued in reply that they do exist, because an error in the original NGC (that had misled Sulentic and Dixon) had been corrected by Dreyer himself. Brownlee also pointed out that the epoch 1950 *Master List* positions differed by half a degree in right ascension from those given in the *Second Reference Catalogue*.

In an attempt to resolve the matter, I sent a note to Gerard de Vaucouleurs and Harold Corwin, pointing out the identification problem, and giving an account of the inconsistencies uncovered thus far. I received a very prompt reply from Dr. Corwin. It turned out that he had resolved the problem years ago! In preparing the *RC2*, he measured precise positions for several galaxies in the field, and compared them with Dreyer's *corrected* NGC positions. The result was a near perfect agreement and left no doubt that the seven NGC numbers were properly applied to the Septet. The corrections that Dreyer had published were overlooked during the preparation of the *RNGC* and consequently the *MOL*, which is based in part on the *RNGC*. Thus when Sulentic and Tifft checked the *Sky Survey* plates for the appearance of these objects, they could not find them because of the error in right ascension — and thus they noted the galaxies as "nonexistent." Dr. Corwin wrote that the *CGCG* and *MCG* are both correct except for omitting NGC identifications. His letter included copies of tables showing corrections and identifications to all the basic catalogues, and these I've given below.

To cut a long story short, it seems I had detected visually four of the seven galaxies. In the 10-inch scope at 190x, I saw a 12th magnitude star (see photograph) with two spots aligned northeast/southwest to the south of it. These spots were NGC 3750 and the close pair NGC 3753/54, which merged visually. A few minutes of arc south of these, I saw another very faint spot near a faint star between the magnitude 12 star and the magnitude 8 star to the south-southeast. This was NGC 3751, a marginal object for a 10-inch aperture as it has a photographic (blue) magnitude around 15.5. In any case, the next time this region rolls around, I hope to see *all* the members of this interesting group of galaxies.

To help others who may want to explore the Septet, I've included the correct data, sorted out at last.

Brian Skiff
421 West Aspen
Flagstaff, AZ 86001

Aperture Comparisons

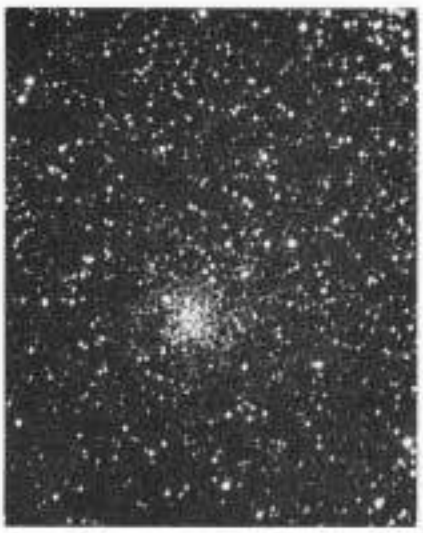
One of the most interesting — and to the beginner, confusing — facets of deep-sky observing is comparing how objects appear through telescopes of different size apertures. In a 6-inch scope, for example, a galaxy like M33 resembles a fuzzy circular glow; in a 12½-inch, you start to pick out intricate details. I became so intrigued by the idea of comparing views that a while back, I made a series of off-axis masks for my 12½-inch reflector, and tested out a number of objects using different aperture stops. In effect I had four telescopes with which to observe: a 6-inch, an 8-inch, a 10-inch, and a 12½-inch. During the test the sky conditions were pretty good, but there was a small amount of upper air turbulence which slightly distorted stellar images.

I chose three targets based on their familiarity to me and progressive degrees of difficulty — M37 in Auriga, NGC 2158 in Gemini (in close proximity to M35), and M79 in Lepus. If you own a small telescope, perhaps these observations will one day help you decide how to "move up" in deep-sky performance.

Open Cluster M37 in Auriga

6-inches: The cluster is very well resolved. Over 100 stars are visible at 50x, but only the bright "central star" can be discerned when looked at directly. (The others were "suspected" with averted vision.) The group is very alluring at 75x and shows gaps between stars. At this power the field is "wall-to-wall" with stars.

8-inches: The abrupt brightness increase over the 6-inch aperture is pronounced. A dozen or so other stars are held with direct vision; the central star is now a pale red. Even at 50x stars cover the field, and there are dark "channels" between the stars. There are also large, empty voids — a



NGC 2158 Lee C. Coombs

particularly outstanding one lies southeast of the cluster's center — that stand out at 75x.

10-inches: Another obvious jump in brightness. Fifty or so cluster members are held with direct vision, perhaps more. The central star is now unmistakably orange-red in color. The cluster overflows the field of view.

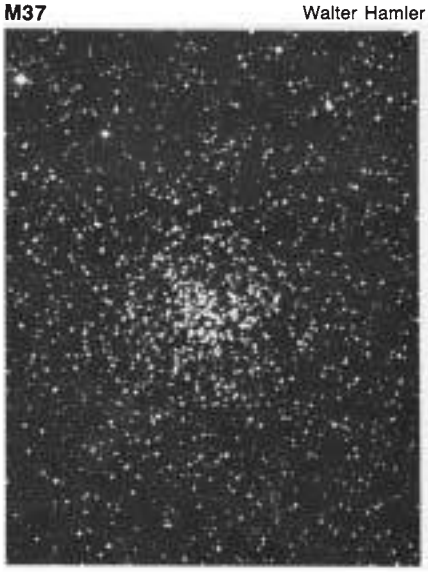
12½-inches: The great majority of stars are held with direct vision. However, they do not "blaze forth" — they are simply seen quite plainly.

Open Cluster NGC 2158 in Gemini

6-inches: I spotted the cluster immediately at 50x as a hazy patch off the southwest edge of M35. At 75x it appears mottled; at 160x some very minute stars on its western edge are resolved. Are these actual members, or only brighter foreground stars? Otherwise, the haze is unresolved.

8-inches: At 160x and 210x, the cluster is definitely resolved straight across its face with a background of haze. Averted vision is a must, however.

M37 Walter Hamler



M79 Tom Dessert

10-inches: It is sharply resolved at 160x and 210x. Still, the background haze defies resolution into stellar points.

12½-inches: The group breaks up into minute points of light with a background haze still present, but only at 75x. It is pretty well seen at both 160x and 210x. It appears there is about the same quantity of stars resolved as in the 10-inch view, but the cluster becomes brighter with the greater aperture, and holds high magnifications easily. There are five stars on the cluster's western edge that were only glimpsed with the 6-inch.

Globular M79 in Lepus

6-inches: Just a circular spot of haze at 75x, at 160x a tiny star toward the north is visible near the cluster, and at 210x a hazy periphery looks mottled. There is no resolution of individual stars.

8-inches: The object is noticeably brighter. The tiny star visible in the 6-inch has become fairly plain at 75x. Still there is no distinct resolution, but only the suspicion that certain of the cluster's brighter members are fleetingly revealed. The eye records something on the cluster's periphery, but by no means is this truly resolved.

10-inches: There is a distinct mottling across the core. Some resolution is visible on the group's outer edges, but these stars are very dim at 210x.

12½-inches: The group is clearly resolved on its outskirts, but not spectacularly so.

If you have been considering a larger telescope, I hope these comparisons will be of use. My scope's secondary has an effective diameter of 2.14-inches; that large a secondary undoubtedly caused some loss of contrast in the smaller apertures, particularly the 6-inch. An ordinary 6-inch telescope with a 1.5-inch secondary would probably outperform the masked-down 12½-incher in a side-by-side competition.

Vern Burns
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Washougal, WA 98671

DSM Reviews

Galaxies
by Timothy Ferris
with illustrations by Sarah Landry
Stewart, Tabori, and Chang
New York, 1982
192 pages, 9¾″ x 10″
cloth $27.50, paper $16.95

Rarely does a book on deep-sky objects arrive that is both pretty *and* informative. In 1980, when *Galaxies* appeared in its original incarnation as a large-format coffee table book, friends of mine shrugged it off as merely an expensive picture book. Admittedly, it contains 39 exquisite color and 106 black and white images, but it also presents an informative, refreshing text written on a non-technical level.

Probably the majority of the book's original potential customers shyed away from the $75 price tag and sought refuge in libraries where they could stare at the pictures and enjoy Ferris' lively writing style. With this in mind, the book was re-released in 1982 in a smaller, less expensive format. It now measures 9¾″ x 10″, and the many full-bleed photos are still impressive.

The text is non-technical, yet it is enjoyable for even experienced deep-sky observers. Ferris begins by asking "Where Are We?"

After defining the structure of the neighboring part of our Galaxy, he explains what a galaxy is and the reader is off and running. A fine section on the Milky Way and its components — stars, gas, and dust — describes the relationship between our solar system and the rest of the Galaxy, and places that in perspective by using diagrams of a typical spiral, the Milky Way. Stellar behavior is investigated by a close look at emission nebulae like M42, M16, the Rosette Nebula, and the Eta Carinae Nebula. Ferris explains why these regions exist and what will happen to them, and proceeds to open and globular clusters, again defining these objects and what they are made of.

In a portion devoted to the death of stars, details of planetary nebulae, novae, and supernovae appear, and the concept of black holes gets a small amount of coverage.

Having informed the reader about the nature of stars and how they tend to act, the following part of the book travels outward to the Local Group. Here the main thrust of the work comes together as galaxies as whole units of matter are examined. The approach of "taking off in a spaceship of the imagination" lends an added interest — certainly aimed at enthralling beginning readers — and works pretty well. Ferris' enthusiastic prose heightens the outlook on how all of this material ties together: *"To exit a galaxy is no handy matter, but eventually we attain a sufficient remove to be able to view the galaxy spread out below us. The central bulge of the galaxy looms directly under us, its shape and color like that of a hill of sand. The galactic disk surrounds it, a monumental tangle stretching to the celestial horizons."*

A fine diagram showing radio wavelength contours outlines the Magellanic Stream, the huge loop of cold hydrogen that encapsulates the Milky Way. Another line diagram interestingly plots the positions of all of the Local Group members, and this type of illustration makes the relationship between celestial bodies crystal clear.

Investigating the variety of galaxies in the universe, Ferris briefly checks in on galaxy classification, citing photographic examples of different types of spirals, barred spirals, ellipticals, lenticulars, and irregulars.

On page 112 Ferris describes the relationship between time and space, and the text becomes even more intellectually stimulating. Alexander Brownlee's photo of NGC 5248 and Pluto appears as an example of extreme "depth of field," and the reader gets a taste of an interesting experiment in relating distance and time in supernovae explosions.

The next section is equally as intriguing: violent and peculiar galaxies are outlined, including reports on M87, NGC 5128, and NGC 2685. And the effects of large-scale gravitation are discussed in a section on interacting galaxies, which describes systems such as M51, M81 and M82, NGC 4631, and the "Siamese Twins," NGC 4567 and NGC 4568. Then ring galaxies — those which result from the collision between a large spiral and a smaller galaxy, which leaves a "hole" in the center of the larger body — are explained.

Finally, Ferris gets to clusters of galaxies and we find how individual galaxies clump together just like stars, to form clusters. Our Galaxy is indeed a member of a "Local Supercluster" which holds the Local Group, the Ursa Major groups, the Virgo cluster, the Pavo-Indus cloud, and similar groups in Leo and Canes Venatici. The final section of the book is devoted to a further look at the geometry of space and time, the expansion of the universe, and "lookback time"; the effects of distance and time on our view of other objects in the cosmos. This final section is far and away the most philosophical, and perhaps the most interesting.

The book's photographs serve to enhance the text — the converse isn't the case — so it is surely more than a picture book. This isn't to say that the photos aren't breathtaking; shots of the interior of the Eta Carinae Nebula, shock waves in the Crab Nebula, NGC 6744, NGC 5128's halo, and several others particularly impressed me. Landry's diagrammatical work was also very well-done, and the pseudo-three dimensional views of clusters of galaxies, locations of nearby objects in the Galaxy, and lookback time were all superb.

So to sum it up, Ferris' book is a wonderful, colorful guide to objects in the universe and thoughts on cosmology. It will be understandable to a wide audience, and is very interesting reading for experienced skywatchers. Ferris' slick readable style will make it a pleasure for you to read this work — once I started on page 1, I didn't stop until page 192. — *Dave Eicher*

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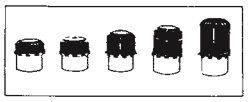

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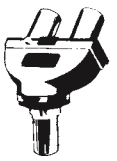

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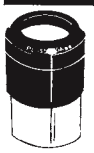

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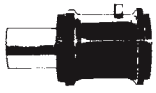

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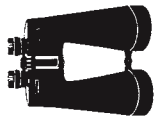

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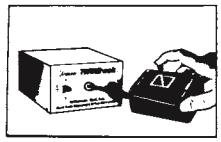

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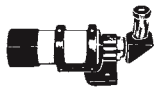

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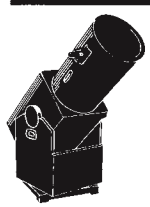

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Scanning the Literature

Again we take a look at papers published in the three principal American journals of professional astronomy, the *Astronomical Journal* (A.J.), the *Astrophysical Journal* (Ap. J.), and the *Publications of the Astronomical Society of the Pacific* (PASP). The articles listed below are relevant to amateur observers and astrophotographers, but looking up the journals will likely involve finding a well-stocked college or university library, or checking out what the nearest astronomy department has to offer.

July-December 1981

Only one paper of interest to deep-sky observers appeared in *PASP* during this six-month period. This was Douglas Forbes' article in the August-September issue (vol. 93: page 441). Entitled "UBV Photometry of Be 62 and Be 86," this paper gives photoelectric magnitudes of brighter stars in these two "Berkeley" open clusters, which are sparse objects located in Cygnus. The measured stars are all brighter than V =14, and are identified in labeled photographs of each cluster.

For southern hemisphere observers there is a similar paper in the *Astronomical Journal* by Ken Janes, entitled "Photometry of the Open Clusters NGC 3960 and NGC 5823" (86: 1210, Aug 1981). Janes presents magnitudes and colors for about 50 stars in each cluster, the brightest of which are approximately V=12. A photograph of each cluster appears with the article.

In "Photometry in the Ancient Open Cluster NGC 6791" (*A.J.* 86: 1332, Sept. 1981), William E. Harris and R. Canterna make new photoelectric observations for some stars in this cluster in Lyra. These observations improve data given in a classic study by Kinman published in 1965.

B and V photometry for about 1450 stars is given in "The Main Sequence of the Globular Cluster NGC 3201" by Gonzalo Alcaino and William Liller (*A.J.* 86: 1480, Oct. 1981). Two photos of the cluster (located in Vela) identify the stars, which range in V magnitude from 11.5 to 19.5.

The very next paper in the same issue of *A.J.* is called "Four Color Hβ Photometry for Four Southern Open Clusters" by Peter B. Stetson (86: 1500). The four-color "Stromgren" system, in combination with measures of the strength of the Hβ line, can give important information about the chemical composition, temperature and interstellar reddening of stars. Here measures are given for a dozen or so stars each in NGC 2437 (which is M46 minus the planetary nebula NGC 2438), NGC 2653, NGC 4103, and NGC 5822. Very nice photos are presented of each object.

Another of Halton Arp's controversial studies on the coincidence of quasars and galaxies is "Quasars Near Companion Galaxies" (*Ap.J.* 250: 31, 1 Nov. 1981). Arp shows statistical correlations of 22 quasars with bright galaxies and their companions. The controversy arises because all of these galaxies are relatively nearby ones (Local Supercluster members, say) yet quasars with far greater redshifts (implying great distance) seem to gather around the nearby galaxies. No one, including Arp, can provide a reasonable physical cause to explain this statistical association of quasars with galaxies. In case you're worrying, the article is relatively easy to read for those with only a little astronomical background; it is strictly an observational study. Accompanying the work are excellent Schmidt photos of the following galaxy fields: NGC 157, 936, 2534, 2549, 2701, 2841, 2903/11, 3073/79, 3184, and 5112.

Some avid amateur observers have expressed interest in viewing galaxies that appear exactly edge-on to our line of sight. "Spectroscopic Observations of Superthin Galaxies" by Jean W. Goad and Morton S. Roberts (*Ap.J.* 250: 79, 1 Nov. 1981) includes photos of NGC 2366, IC 2233, and UGC catalogue objects 7170, 7321, 9242, 4943, and 3697 (the "Integral Sign" galaxy).

January—June 1982

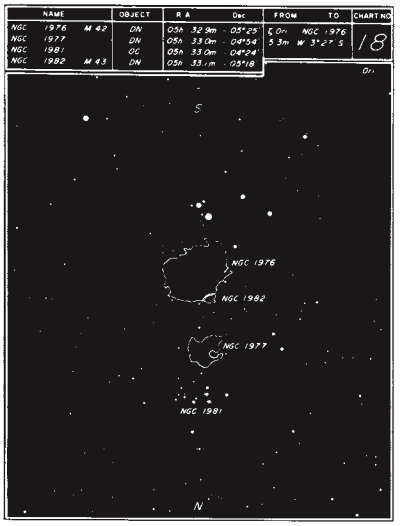
In the February *PASP* is an interesting short paper, "A Distant Star Cluster in Hydra, AM-4," by Barry F. Madore and Halton C. Arp (94: 40, Feb. 1982). This object is probably an extremely distant globular cluster discovered by the authors on ESO/SRC Southern Sky Survey plates. They estimate an approximate distance of 200 kiloparsecs, with the brightest stars of approximately magnitude B=21. The discovery Schmidt photo is shown.

"Upgren 1, An Old Open Cluster Near the End of Its Life," by Arthur R. Upgren, A.G. Davis Philip, and Willet I. Beavers (*PASP* 94: 229, Apr. 1982), describes a sparse group of seven stars in Canes Venatici whose members are between 7th and 10th magnitude. Multicolor photometry, spectral types and radial velocities are given for the cluster, which lies at a distance of only 117 parsecs (closer than the Pleiades). The object probably had many more stars originally, but because of its age most of them have been torn away by gravitational encounters in the Galaxy.

Close scrutiny of a southern galaxy is given in "Colliding and Merging Galaxies. I. Evidence for the Recent Merging of Two Disk Galaxies in NGC 7252" by Francois Schweizer (*Ap.J.* 252: 455, 15 Jan. 1982). The author argues that loops and tails in this magnitude 12 object indicate the collision of two disk systems, possibly early-type spiral galaxies. Nice CTIO 4-meter photos and a wide array of photometric and spectroscopic observations are presented as evidence.

Brian Skiff
421 West Aspen
Flagstaff, AZ 86001

SARNA DEEP-SKY ATLAS



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